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Manual of Recommended Water Sanitation Practice Accompanying United States Public Health Service Drinking Water Standards, 1942

Prepared by Technical Subcommittee

Introduction

IN its report accompanying the 1942 Drinking Water Standards the Advisory Committee recommended, as the principal change to be incorporated in the revision, a separation of the text into (*a*) that portion containing the statement of the Standards,. and (*b*) that portion which constitutes a recommended manual of water works practice, representing the judgment of the technical subcommittee, composed of officers of the Public Health Service, and which is to serve as a guide to the reporting agency. The Advisory Committee further stated, "This latter portion of the text is not to be considered as part of the Standards which must be met in order to obtain certification of the water supply."

In undertaking the preparation of a manual such as envisioned by the Advisory Committee, the technical subcommittee has recognized that no comprehensive treatise on water supply practice is needed in this connection, in view of the several excellent texts which have been published on this subject, including a recent manual (1) issued by the American Water Works Association. It considers its task, in

EDITOR'S NOTE: This manual is not to be considered as part of the Standards which must be met in order to obtain certification of the water supply, but is intended to serve as a guide to the reporting agency.

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fact, to be limited to a comparatively brief and general description of those features of water supply systems and their operation which may be said to conform to accepted principles of good sanitation. It is very largely with these features that the reporting agency is concerned in forming a judgment as to whether or not a particular water supply may meet reasonably acceptable sanitary requirements in respect to its source and protection, as prescribed in section 2 of the Standards. As a further aid to the reporting agency, a section designated as part IV, containing an explanatory discussion of the bacteriological and chemical requirements of the Standards, has been added to this manual. This section is virtually an appendix, as it deals with a subject quite distinct from that of the other sections of the manual.

The main text of the manual, other than part IV, is divided into three sections, parts I, II, and III. In part I are given in outline form those features of water supply systems which may be included in the sanitary survey, including a list of major sanitary defects and health hazards which would be detrimental to the safety of a water supply. In parts II and III are two sections dealing, respectively, with recommended sanitary requirements for water treatment and for water distribution systems. These two parts of the manual are in the form of a connected discussion, amplifying the outline material given in part I.

In preparing the manual, full advantage has been taken of criticisms of the preliminary text by various members of the Advisory Committee. Although it obviously would be impossible to reconcile fully the conflicting views of any group as large as this committee, an effort has been made to follow, so far as practicable, the consensus of opinion among a majority of the committee. The writers of the manual take this opportunity to acknowledge gratefully the many helpful comments which have been furnished by members of the Advisory Committee on the material herein presented.

In preparing the present manual, cognizance has been taken of the need which exists for affording somewhat greater sanitary protection to certain features of public water supply systems and their operation under the existing wartime conditions than might be considered as essential under those of peace. In general, however, an effort has been made to write the manual from the viewpoint of normal requirements for water sanitation as they would be considered by the reporting agency in connection with the application of the Drinking Water Standards.

Part I—Physical Features of Water Supply Systems and Their Sanitary Protection

The physical features of water supply systems may be said to include all of those parts which come within the definition given in paragraph 1.6 of the Standards. According to this definition, "a water supply system includes the works and auxiliaries for collection, treatment, and distribution of the water from the source of supply to the free-flowing outlet of the ultimate consumer." Strictly interpreted, sanitary protection would be concerned with all of those parts of a water system which come within this definition, though for practical purposes the attention may be concentrated mainly on those parts which have to do with sources, treatment and distribution of the water.

A. Scope of Requisite Information as to Source and Protection

In order that the administrative authorities may have the necessary information upon which to base their action, it is required that each water supply coming under consideration be carefully studied with reference to its source and protection. The precise scope of such a study and of the report thereon will vary according to the circumstances existing in each individual case and cannot be fully specified in any general terms. The general procedure, however, should be substantially as follows:

1. *A sanitary survey of the water supply should be made by a competent person.* The reliability of the data collected will depend largely upon the competence of the person by whom the survey is made, and the careful selection of personnel for this duty is of primary importance. The qualifications which constitute "competence" cannot be precisely defined, but, in general, the person making the survey should have received a technical education in the basic sanitary sciences equivalent to that given in a course in sanitary engineering in a recognized college of engineering or school of public health; he should have a broad knowledge of the sanitary features and physical facts concerning water supplies for potable use and he should understand the essential features of water purification plants, their operation and methods of testing.

2. *A brief general description of the water supply should be submitted.* This should include the name of the owner of the supply and a brief description of sources and catchment areas, of the storage available both prior to and following any treatment and of the plant, with date of installation of main works and record of subsequent extensions or alterations.

3. *A brief summary of the pertinent facts relating to the sanitary condition of the water supply, as revealed by the field survey, should be submitted.* The following outline will serve to indicate the general scope of the survey. Not all of the items, however, would be pertinent to any one supply, and in some cases items not in the list would be important. Reference should be made to parts II and III of this manual for certain detailed recommendations bearing on various parts of this outline.

(A) Small Ground Water Supplies

1. Nature of soil and underlying porous strata, whether of clay, sand or gravel; thickness of water-bearing strata; depth to water table.

2. Nature of rock penetrated, noting especially existence of porous limestone.

3. Depth to strainers; length of strainer; depth of casing; well construction—material—diameter.

4. Slope of water table, preferably as determined from observational wells or as indicated presumptively but not certainly by slope of ground surface.

5. Nature, distance and direction of sources of pollution.

6. Possibility of surface drainage water entering the supply and of wells being flooded by nearby streams.

7. Methods of protection.

8. Pumphouse construction (floors, drains, etc.); capacity of pumps; drawdown when pumps are in operation.

9. Disinfection—equipment; supervision; laboratory control.

(B) Large Ground Water Supplies

1. General character of local geology.
2. Extent of drainage area likely to contribute water to the supply.
3. Size and topography of catchment area; slope of ground surface.
4. Nature and porosity of soil and underlying strata, whether clay, sand, gravel, rock (especially limestone); coarseness of sand or gravel; thickness of water-bearing strata.
5. Depth to strainers; length of strainer; depth of casing.
6. Population on the drainage area.
7. Nature, distance and direction of local sources of pollution.
8. Pumphouse construction (floors, drains, etc.); capacity of pumps; draw-down when pumps are in operation.
9. Possibility of surface drainage water entering the supply; methods of protection.
10. Methods used for protecting the supply against pollution, by means of sewage treatment, waste disposal and the like.
11. Protection of collecting well at top and on sides; protection other than check valve or gate against back-flow of drain, etc.
12. Availability of an impure emergency supply.
13. Use of tile pipes or other conduits not tight where ground water may be contaminated.
14. Disinfection—equipment; supervision; laboratory control.

Examples of sanitary defects in ground water supplies are:

(1) Caves, sinkholes or abandoned borings used for surface drainage or sewage disposal in vicinity of the source; fissures or open faults in strata overlying water-bearing formations.

(2) Casing of tubular wells, leaky, or not extended to sufficient depth, or not extended above ground or floor of pumproom, or not closed at top; or casing improperly used as a suction pipe.

(3) Collecting well or reservoir subject to back-flow of polluted water through improper drain.

(4) Source of supply or structures subject to flooding.

(5) Leak in systems under vacuum.

(6) Air-lift line or lines cross-connected to a sewer or secondary water supply.

(C) Surface Water Supplies, Unfiltered

1. Nature of surface geology; character of soil and rocks.
2. Character of vegetation, forests, cultivated land, etc.
3. Population and sewered population per square mile of catchment area.
4. Methods of sewage disposal, whether by diversion from watershed or by treatment.
5. Character and efficiency of sewage treatment works on watershed.
6. Proximity of sources of fecal pollution to intake of water supply.
7. Proximity, sources and character of industrial wastes.
8. Adequacy of supply as to quantity.
9. For lake or reservoir supplies—wind direction and velocity data; drift of pollution; sunshine data (algae).
10. Character and quality of raw water—algae, turbidity, color, coliform (M.P.N.), (average, minimum and maximum).
11. Nominal period of detention in reservoir or storage basin.
12. Probable minimum time required for water to flow from sources of pollution to reservoir and through reservoir to intake.
13. Shape of reservoir, with refer-

ence to possible currents of water, induced by wind, from inlet to water supply intake.

14. Measures taken to prevent fishing, boating, landing of airplanes, swimming, wading, ice cutting, permitting animals in or upon the water, etc.

15. Efficiency and constancy of policing.

16. Disinfection of water—kind and adequacy of equipment, duplication of parts; effectiveness of treatment, adequacy of supervision and laboratory control; contact period after disinfection; whether residual free chlorine or chloramines in chlorinated water; residuals carried.

Examples of sanitary defects are:

(1) Absence or inadequacy of chlorination or lack of proper control of chlorination; insufficient contact period with chloramines present in treated water.

(2) Insufficient restrictions on recreational use of streams and reservoirs, together with their marginal lands, in the local catchment area.

(3) Existence of sources of pollution, such as population on watershed, lumbering, hunting, and other activities; leaching cesspools, or sewers draining into streams or lakes of the catchment area, or into the marginal lands adjacent to them.

(4) Improper location of intake with respect to bottom of reservoir and current, or to surface drainage water inlets.

(5) Intake exposed and accessible to trespassers.

(6) For lake supplies—vessels passing near intakes; drift of ice fields; dumping of dredging, garbage, etc., into lake near intakes; inadequate toilet facilities on cribs; non-examination of employees as carriers of water-borne diseases.

(D) Surface Water Supplies, Filtered

1. Catchment area—size; topography; population density (sewered and unsewered); surface geology; reservoirs (capacity and location).

2. Sources of pollution—nature; distance from intake (miles and time of travel); amounts and distances of sewered populations.

3. Sewage treatment on watershed—extent; methods; populations served; effectiveness and uniformity of results.

4. Raw water characteristics—turbidity, color, alkalinity, hardness, iron, etc.; bacterial quality (average and ranges); variations in quality, especially after heavy rainfall or at times of high runoff.

5. Rated capacity of filter plant (mgd.)—output (average and maximum daily); maximum capacity of pumps.

6. Coagulant system—type (solution or dry feeding); chemicals used; dosage rates (average, maximum and minimum); number and capacity of units; reserve units.

7. Mixing and flocculation basins—type; flash mixing (average and minimum times); flocculation (average and minimum times); number, size and arrangement of units; provisions for cleaning.

8. Sedimentation basins (number, size, and retention capacity)—plain sedimentation; post-coagulation sedimentation; methods of cleaning; flexibility of operation; efficiency of turbidity and bacterial removal.

9. Filters—type (pressure or gravity); number; sizes and rated capacities (net filtering area); effective size and uniformity coefficient of sand; washing system (direct or from storage, rates of wash water application); loss-of-head gages; rate controllers

(average and maximum rates of filtration).

10. Filtered water storage—capacity; location; arrangement; covered or uncovered; protection against contamination; methods of cleaning; added storage in distribution system.

11. Aeration—kind, purpose, capacity, location in purification system; efficiency.

12. Disinfection—kind; stages (if more than one); location in purification system; capacity; method of operation; operation control; average, maximum and minimum dosage; chlorine-ammonia ratios (if ammonia used); simple or break-point chlorination (if used); efficiency of each stage.

13. Plant operation and control—technical supervision (trained or untrained, full-time or part-time); number of operators; laboratory control (kind and frequency of tests); plant and laboratory records (kind, extent, use, etc.); meteorological records.

Examples of sanitary defects are:

(1) Excessive raw water pollution in relation to extent of treatment provided (see part II, A, (1)); existence of nearby uncontrolled sources of raw water pollution.

(2) Bypass connections for raw water or partially treated water, whereby insufficiently purified water may be discharged into the distribution system.

(3) Existence of cross-connections within the plant, between conduits or basins carrying untreated or partly treated water and those containing completely treated water.

(4) Deficient output capacity of treatment works, necessitating excessive overloading or occasional bypassing of units.

(5) Lack of competent supervision and operation or of adequate laboratory control.

(6) Deficient or inaccurate operation or laboratory records.

(7) Lack of suitable devices for measuring and recording volumes of water treated; for maintaining continuity of coagulant and chlorine dosage; deficient retention periods in settling basins; or inadequate areas, depths, sizes of sand or washing facilities for filters.

(8) Lack or deficiency in proper chlorination equipment and control; or failure to maintain proper chlorine residuals in the treated effluent at all times.

(9) Lack of suitable protection for purified water; storage capacity less than requirements for safety.

(E) Pumping Station and Collecting System

1. Number, type and capacity of pumps, including reserve; conditions of equipment and method of operation; condition of suction pipes.

2. Emergency intakes.

3. Emergency supply of power; record of power shut-down; effect of shut-down on surges through conduits, etc.

4. Recording apparatus on suction well elevation; rise and fall of suction well elevation.

5. Screens for fish and debris.

6. All sewers, cast iron or otherwise.

7. Curb walls around wells to protect against surface drainage.

8. Continuous or intermittent operation.

Examples of sanitary defects are:

(1) Leaky suction pipes.

(2) Pump not self-priming; unsafe water used for priming.

(3) Suction well or suction pipes

unprotected from surface or subsurface pollution.

(4) Suction well subject to pollution through back-flow of polluted water through drain.

(5) Improper location or inadequate protection with reference to flood waters.

(6) Lack of suitable provision for insuring continuity of pumping service under all possible conditions.

(F) Distribution System

1. Area and population supplied (proportion to total within corporate limits).

2. Type of distribution system, whether by gravity, direct pumping, indirect pumping, etc.

3. Use, location and capacity of reservoirs and standpipes.

4. Adequacy of distribution system with respect to area served, sizes of mains and laterals, circulation of water, storage provided, etc.

Examples of sanitary defects are:

(1) Existence of cross-connections between primary supply and secondary supply of questionable safety at any point in the distribution system.

(2) Return to the system of any water used for cooling; hydraulic operations, etc.

(3) Absence, or inadequate protection, or improper location of distribution reservoirs, standpipes or elevated pressure tanks.

(4) Intermittent service, resulting in reduced or negative pressures in distribution system; sizes of mains and laterals inadequate for preventing negative pressures; presence of dead ends permitting reduced or negative pressures.

(5) Connections to sprinkler systems using toxic solutions as antifreeze.

(6) Repumping on consumer premises when pressure is low (causing negative head).

(7) Connection to sewers and sewer-flushing chambers, and improperly located blowoffs in distribution system.

(8) Lack of check valves on consumer services to prevent back-flow (especially from high building storage tanks), or from ammonia systems at ice plants, or from hot-water systems.

(9) Existence of hydrant wash lines connected to sewer.

(10) Presence of a secondary water system on premises where public system exists.

(11) Lack of suitable plumbing ordinances prohibiting the use of back-flowing toilet or sink fixtures, or permitting the use of storage tanks connected directly to sanitary fixtures without proper vacuum breaker inlets, or permitting unsafe cross-connection between potable and nonpotable water supplies in private premises.

(12) New connections of pipeline joined to the system without prior disinfection of pipes.

(13) Existence of tile or other leaky pipes in distribution system.

(14) Improper location of water pipes in relation to sewers and storm water drains.

Part II—Recommended Sanitary Requirements for Water Treatment Systems

A. General Requirements

(1) Extent of Treatment

(*a*) For purposes of classification with respect to treatment requirements, waters acceptable for treatment may be divided into the following groups:

GROUP 1. *Waters requiring no treatment*—This group would be limited to underground waters subject to no possibility of contamination and meeting in all respects the requirements of these Standards, as shown by regular and frequent sanitary inspections and laboratory tests.

GROUP 2. *Waters requiring simple chlorination, or its equivalent*—This group would include both underground and surface waters, subject to a low degree of contamination and meeting the requirements of these Standards in all respects except as to coliform bacterial content, which should average not more than 50 per 100 ml. in any month.

GROUP 3. *Waters requiring complete rapid sand filtration treatment, or its equivalent, together with continuous post-chlorination*—This group would include all waters requiring filtration treatment for turbidity and color removal, waters of high or variable chlorine demand and waters polluted by sewage to an extent such as to be inadmissible to groups 1 and 2, but containing numbers of coliform bacteria averaging not more than 5,000 per 100 ml. in any month and exceeding this number in not more than twenty (20) per cent of the samples examined in any month.

GROUP 4. *Waters requiring auxiliary treatment in addition to complete filtration treatment and post-chlorination*—This group would include waters meeting the requirements of group 3 with respect to limiting monthly average coliform numbers, but showing numbers exceeding 5,000 per 100 ml. in more than twenty (20) per cent of the samples examined during any month and not exceeding 20,000 per 100 ml. in more than five (5) per cent of the samples examined during any month.

Note—By "auxiliary treatment" is meant presedimentation or pre-chlorination, or their equivalents, either separately or combined, as may be necessary. Long-time storage, for periods of 30 days or more, represents a permanent and reliable safeguard which in many cases would provide something more than an effective substitute for one or both of the two other methods indicated.

Remarks—(*a*) Although group 1 conceivably might include exceptional surface waters free of any possible contamination and further protected by storage, it hardly can be considered as a safe general rule to admit any surface water to a public supply without chlorination as a minimum safeguarding treatment, in view of the present increased hazards of chance contamination resulting from the extension of recreational and migratory travel to many hitherto inaccessible places. Under wartime conditions, additional need would exist for extreme precaution in this respect.

(*b*) The limiting monthly average coliform numbers stated for waters of groups 2 and 3 are intended as guides rather than inflexible rules, though they are based on extensive observational data (2) fairly representing present water treatment practice in this

country. Certain recent improvements in water chlorination and its control offer promise of increasing the margin of safety of water purification efficiency, with respect to bacterial removal. These improvements have not, however, become fully incorporated into general practice throughout the country, nor does it appear desirable that they should be regarded as warranting any relaxation in the requirements for raw water quality which experience and present standards of safety would indicate as being necessary for providing adequate protection to sources of water supply in general.

(*c*) For waters of group 4, which differ from those of group 3 only in respect to variability, auxiliary treatment is intended mainly as a factor of safety in controlling variations in coliform numbers within the range of 5,000 to 20,000 per 100 ml. The larger of these two figures represents the maximum safe limit for pre-chlorination, or its equivalent, in addition to filtration treatment and post-chlorination.

(*d*) Waters failing to meet the requirements of groups 1, 2, 3 or 4 would be considered as unsuitable for use as a source of water supply, unless they could be brought into conformance with these requirements by means of prolonged preliminary storage or some other measure of equal permanence and reliability.

(2) Other Raw Water Requirements

In addition to meeting the aforesaid bacterial requirements, waters acceptable for treatment should not contain any toxic or otherwise harmful substances, or organisms not readily and completely removable by ordinary water treatment. Raw waters should be free of excessive amounts of acid, microscopic organisms or organic matters causing any interference with the normal operation and efficiency of water treatment processes.

B. *Design and Construction*

In general, the design and construction of individual water treatment plants will vary with local circumstances and should be in accordance with the results of experiments on the water to be treated. The following recommendations, therefore, are intended only as a general guide to good practice and are to be interpreted somewhat broadly in the light of the particular raw water characteristics and other conditions which may be involved in a given situation.

(1) Plant Delivery Capacity

The delivery capacity of a treatment plant, including filtered water storage at the plant, should always be in excess of the maximum expected draft on any day of the year. The excess of provided capacity over average daily draft may vary from 50 to 100 per cent and normally should be at least 50 per cent.

(2) Plant Location

The treatment plant, including raw water and effluent pumps, should be located at an elevation sufficiently high above surrounding bodies of water and have sufficient auxiliary power to insure continuance of operation under all circumstances, including floods. If located in a valley, the site should be adequately drained so that no surface water can gain access to wells, basins, filter tanks or other units. The plant should be located so that no conduit,

basin or other structure containing or conducting water in the process of treatment can possibly be affected by leakage from any sewer, drain or other source of contamination.

(3) Presettling Reservoirs

Presettling reservoirs should be located above the influence of flood waters. They should be at least two in number, so as to permit continuous operation under all circumstances and should be of sufficient capacity to afford a nominal retention period of at least 1 day and preferably 2 or 3 days. Provision should be made for rapid and convenient removal of sludge from the reservoirs. In the treatment of highly polluted waters of variable quality, provision should be made for coagulation at the inlet and for prechlorination at the inlet or the outlet of the reservoirs, whenever such measures may be necessary. Reservoirs should be provided with boats and life preservers for employee protection.

(4) Coagulation-Sedimentation Basins

In order to insure continuous operation, basins for flocculation and sedimentation of coagulated waters should be at least two in number, should be designed for series or parallel operation and preferably should provide a total retention period of at least 5 or 6 hours, except where the use of preliminary mixing and flocculating devices and continuous sludge removal permit somewhat lower periods with unimpaired efficiency. Inlets and outlets of ordinary straight-flow basins should be at opposite ends of the basins and, if necessary, should be provided with baffles so located as to prevent short-circuiting. Similar baffles may be advantageously installed in the settling compartment. The maximum velocity of flow in the settling compartment should not exceed that which usually is provided in well-designed basins of this type. The length of settling compartments in such basins, if rectangular, should be preferably at least twice the width. Stilling compartments should be provided at basin inlets. If stream use will permit, sludge drains may discharge at points located well downstream from the intake, or intakes, at points removed from the influence of cross-currents passing the intake. Otherwise, suitable sludge disposal areas should be provided. The depth of basins should be such as to maintain proper velocity of flow and sludge removal, the permissible depth being slightly lower with continuous sludge removal. Flow-line elevations should not vary more than a few inches above or below the normal level.

Flash mixing and flocculation tanks—Preliminary flash mixing and flocculating equipment, capable of adequate flexibility of adjustment to provide optimum flocculation under varying raw water conditions, is a highly desirable feature of well-designed modern filtration plants and should be credited as a distinct addition to the sanitary protection afforded by a purification system. An ideal combination of flash mixing and flocculation would provide about 1 to 2 minutes of violent agitation followed by about 20 to 30 minutes of slow mixing to promote flocculation.

(5) Coagulant System

Rapid sand filtration plants should be provided with efficient modern devices for measuring and adding coagulants to the water under treatment. All chemical dosing equipment, whether

of the dry-feed or solution-feed type, should have at least one unit in reserve throughout and should be provided with effective recording and alarm devices to insure continuity of service at all times. An accurate flowmeter should be provided for the water treated and also for dry-feed equipment, suitable gravimetric devices for measuring the amount of chemicals added from hour to hour. All chemical feed equipment should be capable of ready adjustment to variations in the flow of water being treated.

(6) Filters

Slow sand—Slow sand filters, if properly designed and operated, are applicable to the treatment of certain types of relatively clear waters. They preferably should be covered, should be provided with loss-of-head gages, should have a sand depth of 36 to 40 inches and should never be operated with less than 20 inches of depth. The sand should have an effective size of 0.25 to 0.35 mm. and should be operated at rates of about 2.5 million gallons per acre daily. In operating slow sand filters, care should be taken to avoid any sudden increases in the rate of filtration.

Rapid sand—Rapid sand filters preferably should be of the gravity type, in order to permit ready and continuous inspection. The depth, effective size and uniformity of sand should be in accordance with the requirements of adequate yield and filter efficiency. Ordinarily, sand depths of about 30 inches are customary, with effective sand size ranging from 0.40 to 0.50 mm. and uniformity coefficient from 1.5 to 2.0. The rate of filtration should conform to established practice, preferably not exceeding 3 gallons per minute per square foot of filtering area.

In general, rapid sand filters should be designed and operated with a view to maintaining reasonably high efficiency of bacterial removal and the filtering medium should be in good condition, free of mud balls, cracks and other hindrances to efficient filtration. Efficient loss-of-head gages, rate controllers and other essential control devices should be provided.

(7) Filtered Water Storage Reservoirs

Filtered water reservoirs at the plant preferably should be covered and located near, but physically separated from, the plant. Where located below filters, adequate protection against leakage of drainage water from other parts of the plant into the reservoirs should be provided. Trap doors and inspection openings should be properly sealed and locked. Suitable vents, protected against outside contamination, should be provided. All effluent pipes should be properly sealed against leakage and tested by frequent inspections. Filtered water reservoirs should be thoroughly tight against external leakage, should be situated above the groundwater table, and preferably should have no walls in common with any other plant units containing water in the process of treatment.

(8) Inter-Connections, Cross-Connections, Open Connections and Partition Walls

(*a*) No cross-connection or interconnection should be permitted to exist in a filtration plant between any conduit carrying filtered or post-chlorinated water and another conduit carrying raw water or water in any prior stage of treatment.

(*b*) No conduit or basin containing finished water should be permitted to

have a common division wall with another conduit or basin containing raw water or water in any prior stage of treatment.

(*c*) Rewash or filter-to-waste conduits should not be directly connected to any drainage conduit, but should be protected by a suitable one-way gap-delivery connection, so that no back-siphonage can occur under any condition.

(*d*) No conduit carrying raw water or any water in a prior stage of treatment should be located directly above another conduit carrying finished water, with a single common partition between them. This rule is not strictly applicable, however, to cast-iron pipes with tight joints carried in the open and readily accessible for inspection and repair.

(9) Drains

All drainage conduits should be constructed so as to be thoroughly tight against external leakage. They should discharge at points in a river or lake so located that no currents of water can under any circumstances be carried from a drain outlet to the plant intake, or to any other water intake located in the vicinity of the plant. No domestic or other sewer should be permitted to be discharged into the river or lake in the vicinity of a treatment plant intake, or directly above such intake, nor should any drain carrying contaminated surface water be permitted to be discharged likewise.

(10) Chlorination

(*a*) *General:*

Chlorination equipment should be selected, installed and operated so that continuous and effective disinfection is secured under the required local conditions.

(*b*) *Chlorination equipment:*

1. Chlorination equipment should have a maximum capacity at least 50 per cent greater than the highest expected dosage to be applied at any time. It should be capable of satisfactory operation under every prevailing hydraulic condition at the plant.

2. Automatic proportioning of the chlorine dosage to the rate of flow of the water treated should be provided at the larger plants and at all plants where the rate of flow varies more than 50 per cent above or below the average flow. Manual control should be permissible only where the rate of flow is relatively constant and an attendant is always at hand to effect promptly the necessary adjustments in dosage.

3. All chlorination equipment should be installed in duplicate, so as to provide standby units for insuring uninterrupted operation. Duplicate units should be operated frequently to insure workability. A complete stock of spare parts and tools should be maintained for emergency replacements or repairs.

4. A reliable and uninterrupted supply of water, free of coarse suspended matter, should be available under adequate pressure to insure the continuous operation of solution-feed chlorinators. Hydraulically or electrically driven pumping equipment, if used for maintaining such pressure, should be provided with alternative sources of power where necessary to insure continuous operation.

5. Scales, preferably of the indicating and recording type, should be provided for weighing the cylinders of chlorine and checking the losses in weight of chlorine as fed from the cylinders during successive intervals of time. These scales should be suffi-

ciently accurate and sensitive to measure such losses with suitable precision.

6. A sufficient number of cylinders of chlorine should be connected to the chlorinator in use so that adequate operating pressures will be maintained at various temperatures.

(*c*) *Hypochlorite solutions:*

1. Solutions of calcium or sodium hypochlorite should be prepared in a separate mixing tank, then diluted and allowed to settle, so that only a clear supernatant liquid is withdrawn to the solution storage tank and to the chlorinator.

2. The strength of stored calcium hypochlorite solutions should be checked frequently by laboratory test in order to ascertain that no loss of strength has occurred. Calcium hypochlorite solutions should be prepared freshly every 4 or 5 days, unless properly alkalinized with sodium carbonate.

(*d*) *Safety requirements:*

1. Suitable gas masks and a small bottle of ammonia for testing for leaks should be kept at convenient points immediately outside the room or enclosures in which chlorine is being stored or is in use. Gas masks should be inspected at regular intervals and kept in serviceable condition.

2. Chlorinating equipment and cylinders of chlorine should be housed preferably in separate buildings above the ground level, as a measure of safety.

3. The room or building housing chlorinators in service should be maintained at a temperature of above 60°F., but never in excess of the normal summer temperature. The cylinders of chlorine should be shielded, where necessary, from excessive heat or cold. Direct heat should not be applied to cylinders of chlorine, nor should hot water be poured over them or come in contact with the cylinder valve.

4. Adequate ventilation should be provided for all enclosures in which chlorine is being fed or stored.

5. All joints of tubing connecting chlorine cylinders and chlorinators should be kept absolutely tight and inspected frequently to insure tightness. Tubing should slope upward from the cylinders.

(*e*) *Control of chlorination:*

1. Chlorine should be applied continuously to the filtered effluent at a point where thorough and rapid mixing with the treated water will be effected. Free active chlorine should be in contact with the treated water for not less than 20 minutes, or chloramine preferably for at least 3 hours, before the treated water reaches the first consumer.

2. The proper dosage of chlorine will be determined by regular and frequent routine bacteriological and residual chlorine tests, both at the plant and at various points in the distribution system. In general, a safe desirable minimum of residual free chlorine at distant points in the distribution system would be 0.05 or 0.10 ppm., depending on circumstances. For chloramines, the desirable residual would be somewhat higher. The residual carried in the finished water as delivered from the treatment plant should be regulated accordingly. At times of threatened or prevalent outbreaks of water-borne disease, the residual chlorine should be increased, preferably to a minimum of 0.2 or 0.3 ppm. in all parts of the distribution system, if possible, regardless of tastes or odors in the delivered water. Similar measures should be taken in the event of any lapse in the normal efficiency of the treatment plant.

3. Routine sampling points should be maintained at the treatment plant and at several vital points in the water distribution system. Sample collections should be made regularly at the latter points and the samples tested bacteriologically and for residual chlorine. Chlorine demand tests should be made occasionally on samples collected in the distribution system for comparison with the results of similar tests at the treatment plant. Any abnormal increase in the chlorine demand, or decrease in the residual chlorine at any point in the distribution system, should be checked and, if consistently observed, followed up by a thorough physical investigation of that portion of the system.

4. The tests for residual chlorine should be made in accordance with the eighth edition of the *Standard Methods for the Examination of Water and Sewage,* 1936, published jointly by the American Public Health Association and the American Water Works Association. This test should be made at least once during each successive period of 8 hours, every day in the finished water at the treatment plant and at least three times weekly at regular distribution system sampling points.

5. Special care should be taken to maintain a detailed and accurate record of chlorination and the results thereof. Such a record should show: rate of flow of water treated, gross weight of chlorine cylinder in use, weight of chlorine used for 24 hours, setting of chlorinator and time of making, and results of, residual chlorine test.

6. Unless bacteriological and other tests should indicate the need of maintaining higher minimum concentrations of residual chlorine, at least 0.2 ppm. of free chlorine should be maintained in the treated water after a contact period of at least 10 minutes. When chloramine treatment is used for disinfection, the residual chlorine concentration, as indicated by the ortho-tolidine reagent, should be at least 0.4 ppm. after 2 hours of contact. Where break-point chlorination is practiced, a sufficient concentration of residual free chlorine should be maintained at the treatment plant so that it will be not less than 0.05 to 0.10 ppm. at all points in the distribution system. When required in specific instances, the minimum concentration of residual chlorine and the minimum retention period for the chlorinated water should be increased as directed by the State Department of Health.

7. Results of recent studies have indicated that the product of required concentration and period of contact of chloramine with water may range from 20 to 30 times the corresponding product for free active chlorine, in order to obtain comparable bactericidal action. The required dosage can be determined by means of break-point tests of the water and adjustment of the chlorine dosage so as to allow for some absorption of free chlorine in the distribution system initially. This absorption should diminish after the chlorine demand of organic matter remaining in the system has been satisfied.

C. *Operation Control*

(1) Supervision

Every water treatment plant engaged in purifying water for domestic use should be under the charge of a technically trained supervisor. For plants treating variable or highly polluted raw waters, trained supervision should be continuous and full-time. For certain types of small plants, part-time trained supervision may be prac-

ticable under favorable circumstances. Under these conditions, the supervisor should be in constant touch with the plant attendants and available on call in any emergency and should visit the plant at least twice each week.

(2) Laboratory Tests and Control

(*a*) The schedule of laboratory tests followed in controlling the operation of a water treatment plant will vary with the size of the plant and character of water treated, though certain minimum requirements may be stated. For the ordinary plant, the minimum schedule of laboratory tests should include determinations of air and water temperature, turbidity or color (or both), alkalinity, pH value, hardness, residual chlorine, bacterial count at 20°C. or 37°C. (or both) and coliform bacterial numbers, both presumptive and confirmed. Where break-point chlorination is practiced, a continuous record of free ammonia in the water to be chlorinated should be maintained. Occasionally special tests may be necessary, such as for residual alum, iron, manganese or other undesirable constituents of the final effluent. Where pre-chlorination is used in addition to post-chlorination, tests for residual chlorine should be made at each major stage of treatment and, in the raw water, tests for chlorine demand.

(*b*) For operation control at the plant, the frequency of tests, particularly for turbidity, residual chlorine, bacterial count and coliform organisms, though dependent on the character of water treated and on its variability, should be such that at least one test each 24 hours and every day of the week will be carried out. For the larger plants, at least three sets of samples are usually collected daily for bacteriological tests. Determinations of turbidity and residual chlorine are made more frequently, sometimes at hourly intervals, when the character of the raw or partly treated water is changing rapidly.[1]

(*c*) An important though somewhat less tangible element in judging the efficiency of plant operation is the general appearance of the plant and its surroundings. A neat, well-kept plant with attractive grounds is almost invariably an index of efficient operation, though, in some of the smaller plants especially, this criterion may not always be infallible. Mere neatness in the external maintenance of a plant, however, cannot offset lack of proper training on the part of the operator.

In rating the general efficiency of operation control, the following items are of primary importance:

(1) Training and experience of supervisor and operating staff.

(2) Adequacy of operation records.

(3) Efficiency of laboratory control.

(4) Suitability of plant design and construction to the character and pollution of the raw water.

(5) Capacity of the plant in relation to the average and maximum required output.

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[1] The following rule, wholly arbitrary, would give sampling frequencies depending in part on the daily volume of water treated and on the density of raw water pollution:

$$N = \sqrt[3]{VC}$$

where

N = number of samples per 24 hours,
V = volume of water treated in million gallons daily,
C = coliform number, M.P.N., in thousands per 100 ml.

According to this rule, the number of samples per 24 hours would range from 1 to 2 for a 1-mgd. plant with raw water coliforms 1 to 5 thousands per 100 ml. and from 5 to 8 for a 100-mgd. plant with the same range in coliform numbers.

Part III—Recommended General Sanitary Requirements for Water Distribution Systems

A. General

1. A water distribution system should be designed and constructed so as to provide at all times an adequate supply of water at ample pressure in all parts of the system.

2. The safety and palatability of the water should not be impaired in any manner while flowing through the distribution system, or any part thereof.

3. The system should be provided with sufficient valves and blowoffs so that necessary repairs can be made without undue interruption of service over any considerable area.

4. No unprotected open reservoir, or physical cross-connection, whereby unsafe water can enter the distribution system, should be permitted.

5. The system should be tight against excessive leakage and its various mains and branches should be separated from rivers and other possible sources of contamination.

6. The system should be designed so as to afford effective circulation of water, with a minimum of dead ends.

7. The distribution system should be maintained in a sanitary manner, with due precautions against contamination of the water in any part of it as the result of necessary repairs, replacements or extension of mains.

8. Frequent and regular bacteriological examinations should be made of water samples collected at various control points in the distribution system, with an immediate and thorough checking of any unusual results.

B. Piping System

1. The water mains should be of adequate size so that negative pressure will not occur under any condition of draft on the system.

2. Joints should be of such design and should be installed so as to show no leakage under a standard pressure test before covering. Materials used for calking should be of a character such as not to foster the growth of coliform bacteria.

3. Corrective water treatment should be instituted where deposits in the mains tend to reduce the effective size and capacity of the pipes. For biological deposits, heavy chlorination may be effective.

4. The piping system should be designed so as to maintain an adequate positive pressure of water in all parts of the system, regardless of unusual drafts on any parts of the system. Pressure-equalizing standpipes or reservoirs should be located at suitably distant points from the pumping or main supply station.

5. Where dead ends are necessary as a stage in the growth of the system, they should be located and arranged with a view to connecting them ultimately so as to provide circulation.

6. Water pipes should be laid, so far as possible, above the elevation of nearby sewers and at least 10 feet laterally from them. Where this requirement cannot be met because of physical conditions, extra precautions should be taken in securing absolute and permanent tightness of water pipe joints.

7. Where a water service pipe crosses a street sewer at less than 6

feet vertically above the sewer, or is within 10 feet of it horizontally, all of that part of the water pipe lying within these distances should be constructed preferably of copper or brass pipe connected to the iron pipe with a brass fitting. In such cases it is preferable to use copper or brass pipe from the water main to the house, and the house sewers should be constructed of extra heavy cast iron with watertight joints. Where priorities necessitate the use of materials other than brass or copper, extra-heavy iron pipe should be used under these conditions.

8. Sanitary precautions should be taken in laying new water pipes. Where avoidable, pipe should not be laid in water or where it can be flooded with water or sewage in laying. Leakage tests should be made by means of hydrostatic pressure. New mains should be kept filled with a strong hypochlorite or chlorine solution (40–60 ppm. of chlorine) for at least 24 hours and then drained before being placed in service. Fire hydrants should not be drained into the sewers or storm drains. Valve chambers should be of watertight construction and should not be connected directly to a storm or sanitary sewer.

C. *Cross and Open Connections*

1. In general, no physical cross-connection should be permitted between a public or private water distribution system containing potable water and any other system containing water of questionable safety.

2. Open connections, physically separated, may be permissible under regulation and supervision by the local or state health department.

3. House or industrial toilet or sink fixtures capable of back-siphonage into the water system should be classed as cross-connections and should be prohibited, except where supplied by an independent elevated storage tank physically separated from the water supply pipes and protected by an approved siphon-breaker inlet. Dual water systems should be avoided where possible.

Part IV

A. *Discussion of Chemical Requirements for the Revised Drinking Water Standards*

It is fairly obvious that a water which is turbid, or colored to a degree which is easily noticeable, or which has an unpleasant or unusual odor or taste, will be looked upon with suspicion by the consumers to whom it is served for drinking purposes. For this reason its use should not be permitted where clarification of the water is practicable, or where a more acceptable supply is available.

The presence of considerable amounts of calcium and magnesium salts makes the water unsuitable to use for washing, and it is also unpleasant for drinking to persons who have been accustomed to softer water, but persons who are accustomed to the harder waters may find the softer waters less agreeable to their taste. Although it is open to question whether it would be justifiable to require the dilution of hard water by distilled water in order to keep within the limits specified in the Standards, it would be proper to require carriers to select the local sup-

plies which most nearly fulfill the requirements of the Standards with respect to mineral content.

Insofar as the chemical composition of the water may cause inconvenience by its irritating effect upon the intestinal canal, or by any more serious effect upon well-being, the certifying authority will be justified in requiring that due regard be paid to this matter by common carriers. Unfortunately, it is difficult to secure reliable information concerning the physiological activity of salts as found in waters. Idiosyncracy is important. It is universally admitted that poisonous or otherwise harmful elements or salts in significant quantities, such as lead, hexavalent chromium, arsenic, fluoride or selenium, should not be allowed in water for drinking or culinary purposes. It is difficult, however, to fix limits for the less poisonous substances or salts which are normally present. The effect of sulfates, and especially of magnesium sulfate, is, however, well recognized, and it would be desirable to avoid the use of waters in which the concentration of these salts is sufficiently high to be annoying. The use of salts of barium or of hexavalent chromium for treating the water or water system should not be allowed on a drinking water supply. Molecularly dehydrated phosphates have come into use for water treatment, but sufficient information upon the physiological effects of small amounts of these salts is not available. Consequently, their use in excess of 10.0 ppm. for treating any drinking water should be avoided. When waters are treated with chemicals in order to soften or to purify them, it is desirable that any excess use of the chemical be avoided. Limits for alkalinity resulting from excess lime or other softening procedures already have been suggested. More than a small amount of free chlorine (1.0 ppm.) or chloramine (2.0 ppm.) is objectionable in the effluent from a treatment plant because of resulting chlorinous taste in the water. In general, it is considered proper to insist that effort be made to find waters which are as satisfactory as possible from the standpoint of chemical characteristics, but with due regard to the region within which the water supply must be obtained.

Relation between pH, total alkalinity, hydroxide, carbonate and bicarbonate alkalinities in waters—In the chemical analyses of water, it is often desirable to know the concentrations of hydroxide, carbonate and bicarbonate alkalinities present in the sample, as well as the total alkalinity to methyl orange. At present, according to *Standard Methods* (3), the OH^-, $CO^=_3$ and HCO^-_3 components of a total alkalinity are calculated from the values for the methyl orange (T) and phenolphthalein (P) alkalinities by means of the relations given in part II, section VI, paragraph 3.1 (p. 66). Experimentally, the phenolphthalein titration of samples containing carbon dioxide and mixed carbonates is far from satisfactory. Furthermore, the formulas for calculating the amounts of OH^-, $CO^=_3$ and HCO^-_3 alkalinity from the values of P and T ignore the laws of chemical equilibrium. The formulas assume that neither OH^- and HCO^-_3 nor $CO^=_3$ and CO_2 may exist in the same solution, assumptions which are quantitatively incorrect. Also the formulas give values for OH^- which too often do not check with those calculated from the pH of the water.

On the basis of the ionization equilibria of carbonates and water, De-

Martini (4) formulated equations by means of which the concentrations of CO_2, HCO^-_3, $CO^=_3$ and OH^- present in a given sample can be calculated from the values for pH and total alkalinity. Moore (5), using the best available values for the ionization constants of carbonic acid and water, presents the DeMartini equations:

$$(1)\quad OH^- \text{ (in terms of } CaCO_3) = \frac{5 \times 10^{-10}}{(H^+)}$$

$$(2)\quad CO^=_3 \text{ (in terms of } CaCO_3) = \frac{5.61 \times 10^{-6}}{(H^+)} \times A$$

$$(3)\quad HCO^-_3 \text{ (in terms of } CaCO_3) = 50{,}000 \times A$$

$$(4)\quad CO_2 \text{ (as } CO_2) = 9.70 \times 10^{10} \times (H^+) \times A$$

$$\text{Where A is the factor } \frac{\dfrac{T}{50{,}000} + (H^+) - \dfrac{10^{-14}}{(H^+)}}{1 - \dfrac{11.22 \times 10^{-11}}{(H^+)}}$$

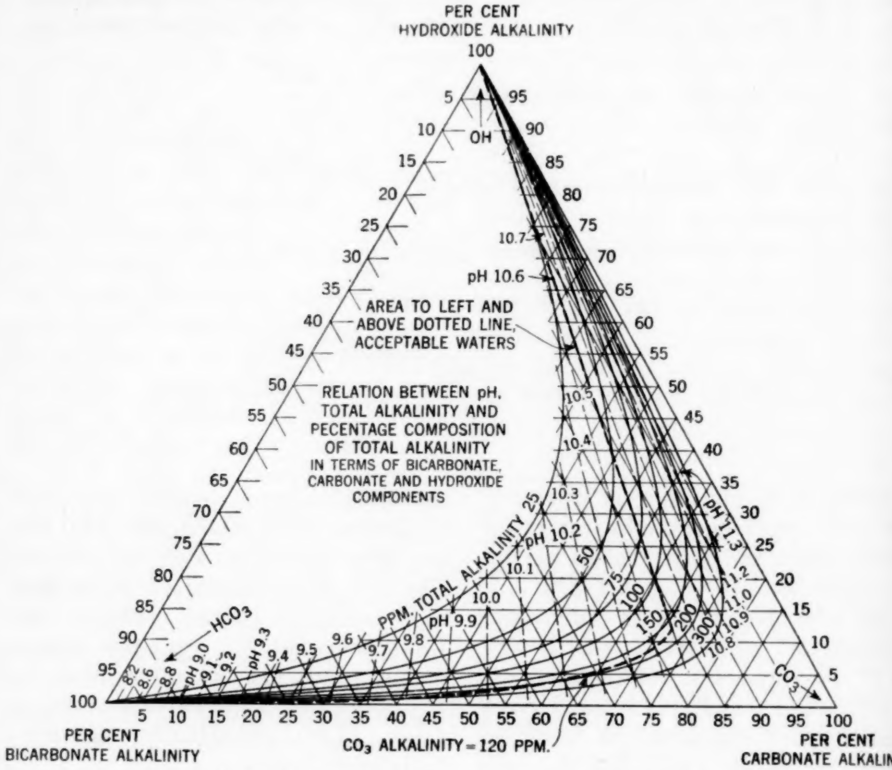
in which T stands for total alkalinity and (H^+) represents the hydrogen ion concentration and is related to pH by the expression $pH = \log 1/(H^+)$.

The total alkalinity is an equilibrium mixture of its OH^-, $CO^=_3$ and HCO^-_3 components. If the amounts of OH^-, $CO^=_3$ and HCO^-_3 in a given alkalinity are expressed in terms of percentage of the total alkalinity, any given equilibrium mixture can be represented by a point on a triangular co-ordinate diagram. The triangular diagram has for its three co-ordinates the per cent fractions of each of the three alkalinity components, OH^-, $CO^=_3$ and HCO^-_3. These vary from 0 per cent at the three sides of the triangle to 100 per cent at the opposite apex.

Using Moore's equations, the amounts of OH^-, $CO^=_3$ and HCO^-_3 in equilibrium with each other at pH values ranging from 7.0 to 11.6 for alkalinity values of 25, 50, 75, 100, 150, 200, and 300 ppm. were calculated, converted to the per cent fraction basis and plotted on the triangular diagram. The curves show how the relative proportions of OH^-, $CO^=_3$ and HCO^-_3 for any given alkalinity change with pH. In the diagram there are presented curves for waters with total alkalinities of 25, 50, 75, 100, 150, 200, and 300 ppm. (heavy solid line curves). The thin lines running from the base of the triangle to the opposite apex (100 per cent OH^-) represent samples of any given pH and show how, for any given pH, the relative amounts of OH^-, $CO^=_3$ and HCO^-_3 will vary with total alkalinity.

The proposed Standards set the following limits: (1) the water shall not have a pH greater than 10.6, and (2) the carbonate ($CO^=_3$) alkalinity shall not exceed 120 ppm. The thick broken lines represent these limits. All samples whose compositions are represented by points to the left of the 10.6 pH tie-line and above the 120 ppm. $CO^=_3$ line are acceptable. All samples of composition represented by points to the right of and below the limiting lines are to be rejected.

Because chemical equilibria are affected by change in temperature and by changes in the ionic strength of the solution, Moore's equations are strictly valid only for waters at 25°C. and low dissolved solids concentration. (Ionic strength is more or less proportional to dissolved solids concentration.) However, for practical purposes the equations will hold quite accurately for all pH values up to 10.0 in waters containing up to 500 ppm. dissolved solids at temperatures from 15° to 25°C.



Relation Between pH, Total Alkalinity and Percentage Composition of Total Alkalinity

B. Discussion of Bacteriological Requirements for the Revised Drinking Water Standards

The bacteriological examinations which have come to be recognized generally as of most value in the sanitary examination of water supplies are:

(1) The count of total colonies developing from measured portions planted in agar or gelatin plates and incubated for 48 hours at 20°C.

(2) A similar count of total colonies developing on agar plates incubated for 24 hours at 37°C.

(3) The quantitative estimation of organisms of the coliform group by applying specific tests to multiple portions of measured volume.

Of these three determinations, the test for organisms of the coliform group is almost universally conceded

to be the most significant because it affords the most nearly specific test for the presence of fecal contamination. Only this test has been included, therefore, in the bacteriological standard recommended, as neither the 37°C. nor the 20°C. plate count would appear to add information of sufficient importance, for the purpose of these Standards, to warrant their inclusion in the required examination. The omission of plate counts from the Standards is not to be construed, however, as denying or minimizing their importance in routine examinations made in connection with the control of water purification processes.

For the purposes of the Standards the coliform group is defined as including all organisms considered in the "coli-aerogenes" group as set forth in *Standard Methods for the Examination of Water and Sewage,* eighth edition (1936), as prepared, approved and published jointly by the American Public Health Association and the American Water Works Association, New York City.

In accordance with this definition, the Standards provide that the procedure required for demonstration of the coliform group be as prescribed in *Standard Methods,* eighth edition, 1936, referred to above, for the tests designated:

(*a*) The completed test, or

(*b*) The confirmed test, when a liquid confirmatory medium (brilliant green lactose bile broth, 2 per cent) is used, provided the formation of gas in any amount in this medium during 48 hours of incubation at 37°C. is considered to constitute a positive confirmed test, or

(*c*) The confirmed test where (1) crystal violet lactose broth, (2) fuchsin lactose broth, or (3) formate ricinoleate broth are used; providing the worker demonstrates the conformance of results, obtained with these three media, to the required conditions.

Moreover, it is recommended that this reference to *Standard Methods* shall be considered as applicable to all details of technique, including the selection and preparation of apparatus and culture media, the collection and handling of samples, and allowable intervals between collection and examination. As the standard procedure cited in this reference does not require differentiation between the various forms or types which are included under the general definition of the coliform group as given above, it has not seemed advisable, in the present state of knowledge, to require such differentiation in the application of the Standards. Two considerations tend to militate against the necessity or propriety of complicating the Standards by the incorporation of such differentiation. First, an analysis of the records of a considerable number of municipal water supplies during the past 20 years suggests that the coliform group has served effectively as an indicator of fecal pollution when the procedure for the determination of the coliform group was carried out in exact accordance with the methods specified. Second, competent research findings indicate that all constituent members of the coliform group are usually found in human fecal material. Consequently, it seems advisable to emphasize here a strict observance of the methods referred to, rather than to introduce any unnecessary procedures for the differentiation of the coliform group.

The principles involved in the quantitative interpretation of fermentation tests according to the "most probable

number" concept, in multiple portions of equal volume and in portions constituting a geometric series, were discussed fully in appendix III of the Standards promulgated in 1925 and since then this discussion has been amplified by various authors. As these principles now are understood universally and enumeration procedures concerned are used quite widely, it has not appeared necessary to repeat this discussion in the current revision. The testing of multiple portions of equal volume affords a more precise measure of the density of the coliform group within a relatively narrow range of variation than does the testing of portions in geometric series. Therefore, as the waters which will be offered for certification should represent only a narrow range of very moderate pollution, the Standards require that the examination of each sample shall consist of the separate testing of five equal portions either of 10 ml. or of 100 ml. each.[2] For laboratories which are equipped to make such tests, the examination of the larger, 100-ml., portions provides for: (1) a more definite measure of the density of coliform organisms in the range of about 1 per 100 ml., as established by the Standards, and (2) information as to the approach of unfavorable conditions in the water.

The procedure for the examination of 100-ml. portions offers no difficulty in laboratory technique, the only additional requirements being larger containers, larger quantities of media, slightly greater incubator space and the collection of a larger sample. If economy of incubator space is desirable, multiple-strength lactose broth may be used in conformity with the provisions in *Standard Methods of Water Analysis*. In practice it has been found satisfactory to use standard dilution water bottles of 160–180 ml. capacity as tubes or containers for the 100-ml. portions. These bottles, containing 30–35 ml. of quadruple-strength lactose broth and equipped with the ordinary inverted vial or with a Cowles (6) tube, are sterilized in the usual manner. For convenience in checking volumes, or to eliminate the necessity for the use of volumetric pipettes, the bottles may be graduated at the 35-ml. and at the 135-ml. points. This procedure lends itself readily to the planting of samples directly into lactose broth at the site of collection of the sample.

There is, of course, no essential reason why the number of portions tested should be five, rather than some larger number, except that labor and materials are limited and five portions are considered sufficient for such precision as is ordinarily necessary.

With reference to the total number of samples which should be examined, the intervals at which they should be collected and the location of the sampling points on the distribution system, it is recognized that such requirements are affected by (1) the nature of the source of the water, (2) the character and the consistency of the treatment provided, (3) the sanitary conditions of the distribution system, (4) the average daily volume of water delivered to the distribution system, and (5) the total population served. It is obviously desirable, from the standpoint of precision and significance of results, to examine a large number of samples collected at frequent and regu-

[2] It is advisable, however, especially in the examination of waters of unknown quality or which may be suspected to be highly polluted, to make simultaneous tests in portions of a geometric series, ranging from 100 ml. to 1.0 ml. or less.

lar intervals, and, when normal conditions obtain, preferably at uniformly spaced points on the distribution system, but, when abnormal conditions exist, at such points as will produce the maximum information concerning the cause of any abnormalities in water quality. It is obvious also that it is not practicable to lay down hard and fast requirements adapted to the qualities of each supply in question. It has appeared desirable, however, to establish for the ideal supply a requirement for the minimum number of samples to be collected and examined during specified intervals, based on the population served, and to delegate to the inspecting officer, who should have knowledge of the conditions affecting the supply in question, the authority to increase the number of samples required and to fix the times and the sites for collection of samples on the distribution system.

In accordance with these principles, the first requirement stated in the Standards, namely, that "of all the standard 100-ml. or 10-ml. portions examined per month in accordance with the specified procedure, not more than 60 per cent or 10 per cent, respectively, shall show the presence of organisms of the coliform group," may be interpreted as implying that the mean density of organisms of the coliform group shall not exceed about 1 per 100 ml. The second clause of the Standards, which specifies that not more than 20 per cent (or 5 per cent when 10-ml. portions are examined) of samples tested (or not more than one sample if the whole number tested be less than 20 for 10-ml. portions or less than 5 for 100-ml. portions) shall show the presence of organisms of the coliform group in all five 100-ml. portions, or in three or more of the five 10-ml. portions, is more complex in its implications [3] and more difficult to explain. It recognizes that, according to the laws of chance, this result would occur in a certain small proportion of the samples tested, even though the mean density of organisms of the coliform group in the whole body of water tested actually remained constant at about 1 per 100 ml. or less and, consequently, that it warrants no inference of actual fluctuations in density unless it occurs with greater frequency than would be expected according to the theory of chance occurrences. A more frequent occurrence, sufficient to indicate occasional higher pollution, is believed, however, to be an indication of potential danger, even though the average quality of the water should be satisfactory (that is, in conformity to the first provision of the Standards). This clause of the Standards undertakes, therefore, to set a limit to the allowable frequency of positive results in an increased number of portions of any sample. It is necessary in so doing to recognize that water supplies actually do vary in their degree of pollution from day to day, and that in many instances the series of tests which will be considered may be small; hence, the limit (20 and 5 per cent) is set at a frequency which is higher than reasonably might be expected in a large series of samples from a water in which the actual density of organisms of the coliform group never greatly exceeded 1 per 100 ml. In the case of 10-ml. portions, the limit for this frequency is set at 5 per cent, which is approximately five times

[3] This was ably discussed in appendix III of the 1925 Standards and this discussion has been amplified by various authors since that time.

higher than the normal expectancy. With 100-ml. portions, the requirement is somewhat more stringent as the 20 per cent frequency allowed is only about 2.5 times higher than reasonably might be expected. As the possibility of an increase in pollution is ever present, the Standards provide further that when positive results are obtained in increased numbers of portions of any sample, additional and more frequent samples shall be collected and examined. The results from such additional samples will demonstrate whether the increase in positive results are due to the probabilities of chance, or to an actual increase in density of pollution.

In the bacteriological standard which has been promulgated, the committee has undertaken to set up two controlling factors: (1) two limiting values to the density of organisms of the coliform group, one limit applying to the mean density as calculated from the entire series of tests made during any one month and one to the range and frequency of occasional deviations from this mean, and (2) failure to conform with the specified procedures for making the bacteriological examinations may be used as the basis for a refusal of certification of a supply. That is, a failure to follow the specified procedures might produce results which would not provide for a satisfactory opinion of the quality of the water supply concerned.

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Chromium—A Water and Sewage Problem

By D. W. Graham

THE presence of chromium in industrial wastes has created an unusual problem in Southern California. War conditions, particularly the unprecedented expansion of the aircraft industry, have caused such a strain on waste and sewage disposal facilities that, in numerous instances, improper disposal methods have caused pollution of the Los Angeles River and its underground water supply. The chief sources of the chromium compounds found in wastes are chromium plating and the oxide coating of aluminum by the anodizing process.

The dumping of chromium-laden wastes was first brought to the attention of the Los Angeles Bureau of Water Works and Supply in October 1941; but actual pollution of the supply due to these wastes could not be proved until the following spring, when spectrographic examination of the Crystal Springs supply revealed that the chromium had increased from 0.02 to 0.04 ppm. during the year. The figure, 0.02 ppm., had not caused undue concern the previous year in view of the report of Braidech and Emery (1), on 24 American cities, in which "normal" chromium content was indicated to vary between 0.001 and 0.04 ppm., with an average of 0.0053 ppm. The 100-per cent increase in a single year, however, made it necessary to determine the source of pollution as a basis for action. To accomplish this, a survey of strategic San Fernando Valley wells and industrial wastes was made, typical results of which are shown in Table 1.

TABLE 1

Typical Chromium Pollution Analyses

Sources	Date	Cr
War Industries		*ppm.*
Waste from No. 1	7/27/42	15.0
Waste from No. 2	7/27/42	5.0
Waste from No. 3	7/31/42	6.0
Waste from No. 4	7/27/42	8.0
Wash below No. 2	(Various)	2.0–5.0
Valley Wells		
Wells not subject to pollution	7/27/42	0.003
Glendale No. 1	7/27/42	0.007
Burbank No. 4	7/27/42	0.009
Park No. 1	7/27/42	0.050
Park No. 7	7/27/42	0.070
Crystal Springs	1939–40	0.005*
" "	1940–41	0.020
" "	1941–42	0.040
" "	8/11/42	0.050
" "	8/25/42	0.055
" "	9/ 2/42	0.060
" "	9/10/42	0.060
" "	9/15/42	0.060
" "	9/22/42	0.080
" "	9/29/42	0.075

* Estimated.

A contribution by D. W. Graham, Chief Chemist, Bureau of Water Works & Supply, Los Angeles.

It was found that waste waters high in chromium were being discharged from several San Fernando Valley plants into adjacent washes and into the Los Angeles River. From the analyses it became obvious that the chromium from these discharges was polluting the underground water below the point of discharge. Recent tests have shown a steady increase in various wells near the river, to the extent that the chromium present may be approaching a toxic concentration.

Present Standards

The new (1942) revision of the U.S. Public Health Service Drinking Water Standards (2) includes the following statement regarding the chemical characteristics of a potable water supply: "Salts of barium, hexavalent chromium, heavy metal glucosides or other harmful substances shall not be allowed in the water supply system." This provision was designed to prevent the introduction of poisonous chemicals in treatment processes, but does not take into consideration or specify an upper permissible limit for chromium in a water supply. This omission is probably due to the lack of information as to the tolerance of the human system to hexavalent chromium and to the inadequacy of published methods for determining traces of chromium in water supplies.

Toxicological Considerations

Toxicological literature provides numerous references to the relative toxicity of the heavy metals in the acute stage. Hexavalent chromium appears to be about 100 times more toxic than the trivalent chromic ion (3). Gonzales (4) states that 3 g. of potassium dichromate is the fatal dosage. This may be compared with the same author's figure of 5 g. for sodium fluoride and 0.2 g. for arsenic trioxide. Other authorities (5, 6) give comparable figures.

The 1942 Drinking Water Standards (2) place the upper limit for fluoride at 1.0 ppm. and for arsenic at 0.05 ppm. It is, of course, dangerous to attempt direct comparison with other metals and non-metals, since small doses taken over a long period may act in an entirely different manner from large doses in the acute stage. Lead, for example, is not as toxic in the acute stage as chromium and arsenic, but, being a cumulative poison, may be extremely toxic when absorbed in small quantities over a long period. The standards' limit for lead is 0.1 ppm.

One favorable aspect of the chromium problem is indicated by Autenrieth and Warren (5), who state that the elimination of chromium takes place rapidly and that the body is soon free from poison. Nevertheless, in view of the scarcity of information on the tolerance of the human body to small amounts of chromium, it seems reasonable to agree with Negus (7) in his conclusion that: "For all anyone at present knows, amounts of chromium as low as 0.1 ppm. may be physiologically harmful."

Effect on Sewage

The presence of chromium is also of grave concern in sewage disposal works. Jenkins and Hewitt (8) have shown that as little as 0.5–2.0 ppm. of chromate affects the biological demand test and that 10 ppm. will greatly depress the nitrification of sewage and seriously interfere with the activated sludge process. H. E. Monk (9) has discussed the effects of chromate wastes on biological oxidation proc-

esses in sewage and the mechanism of their action on proteins, their precipitation of colloids and their bactericidal action.

Chromium Removal

Since chromuim is not naturally present in water or sewage, the most obvious solution to the problem is to remove the chromium at the point at which pollution occurs. This would necessitate development of a process wherein chromates could be removed from otherwise innocuous wastes.

Consideration of the chemical properties of chromates suggests at least two methods for chromium removal, i.e., precipitation as chromic hydroxide or barium chromate. Either compound is insoluble and would reduce the residual chromium to harmless concentrations.

In the first instance the hexavalent chromium ion would first have to be converted to trivalent chromic form by acidification and reduction with sulfur dioxide, hydrogen sulfide, ferrous salts, iron turnings or other reducing agents. The chromic hydroxide could then be precipitated with caustic or lime. A method utilizing this principle has been suggested by G. E. Barnes and M. M. Braidech (10). Barium chromate can be precipitated by barium chloride. Sufficient sodium carbonate must be added to neutralize any excess acid and the residual chromium to harmless to precipitate excess barium.

The latter method has been tried successfully by Spencer (11) in treating chromium plating wastes. Disadvantages of this procedure are that the sulfates present in the waste will also consume barium chloride, thus increasing costs, and a second poisonous metal (barium) is introduced. This might become significant if the process were temporarily out of control and the waste was being discharged on a watershed contributing to a potable supply. If the effluent were connected directly to the sewer, however, it would not be as significant. In fact, for sewer disposal, the first step of the chromic hydroxide process (reduction to trivalent chromium) may be sufficient, since the toxicity of chromic salts is far less than chromates and, in low concentrations, should have no effect on sewage treatment processes.

A minimum of equipment would be required for either process. A collection sump would be necessary for the discharge from the plating shops or anodizing vats and treatment could utilize one or preferably two cylindrical tanks having an outlet pipe near the top of a bottom cone and a valve at the bottom for sludge removal. Agitation could be best accomplished with compressed air. Small tanks for the storage and feeding of chemicals and simple laboratory equipment for process control would complete the principal items.

Analytical Methods

When the chromium survey was first undertaken, it became imperative to find a rapid, accurate method for determining minute quantities of the hexavalent ion. After considerable study a colorimetric method which depends on the intensity of the reddish-violet color developed by the reaction between hexavalent chromium and diphenyl carbazide was adopted. Chromium in potable waters can now be determined in five minutes to a sensitivity of 0.003 ppm. By suitable modifications this method can also be adapted to the determination of hexavalent chromium in sewage, or to total chromium in either water or sewage.

The studies made during the development of this procedure covered the stability of the reagent, choice of acid, effect of temperature, speed of color development and effect of interfering ions. This investigation revealed that, in general, the rate of maximum color development varies directly with the temperature and acid concentration and that the stability of the reagent and permanence of color varies inversely. Comparative tests using organic and inorganic acids, substantiated Rowlands' (12) choice of sulfuric acid for optimum stability.

The reagent finally evolved represents a compromise between optimum stability of reagent, rate of maximum

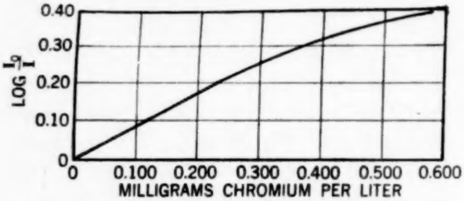

Fig. 1. Photometric Calibration Curve Determination of Chromium With Diphenyl Carbazide

color development and permanence of the final color. This reagent will remain colorless in a 10°C. refrigerator for two weeks, at which time it gradually assumes a brownish-red hue. This color, however, does not seem to affect the sensitivity of the reagent and satisfactory results have been obtained after several months. At normal temperatures, the sample will attain its maximum color within three minutes after the addition of the reagent and will remain within 95 per cent of its maximum intensity for an hour (*see* Fig. 1).

Although the following methods utilize Nessler tubes for color comparisons, those possessing photometric equipment will find these procedures eminently adapted to their use. Figure 2 shows a photometric calibration curve with color intensity plotted against chromium content. A KWSZ photometer with a 500μ Waco green filter was used in this study. Photometric readings should be made from 3–10 min. after addition of the reagent. Any time from 3 min. to 1 hr. is satisfactory when Nessler tubes and freshly prepared standards are used. The optimum range of chromium concentrations for the diphenyl carbazide method subsequently described lies between 0.00–0.04 mg. per 100 ml., as the readings in this concentration most nearly approximate the straight line

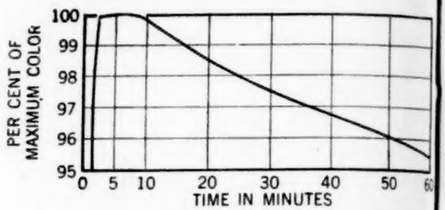

Fig. 2. Stability of Color Produced by 0.20 ppm. Chromium With Diphenyl Carbazide—Photometric Readings

characteristics typical of adherence to Beer's law.

A. Method for Hexavalent Chromium in Potable Water

Ions normally present in potable waters do not affect the determination, nor will Ag, Al, Cu, Pb, Co, Ni, Hg, Mn, Cd or Zn interfere in quantities less than 5 ppm. The most marked interference is that of Fe and Mo, which becomes apparent in quantities exceeding 1.0 ppm.

Reagents: 1. Standard chromium solution—stock solution, 0.3740 g. K_2CrO_4 per 1.; dilute 10 ml. of stock solution to 1 l.; 1 ml. = 0.001 mg. Cr.

2. Diphenyl carbazide—dissolve 0.1

g. in 50 ml. of 95 per cent alcohol and add 200 ml. of 1 : 9 sulfuric acid; keep in refrigerator.

Procedure: Hexavalent chromium is determined by adding 5 ml. of the reagent to 100 ml. of the original sample in a 100-ml. Nessler tube and comparing with standards developed in a like manner. Standards are prepared with distilled water, adding 0.0005 mg. to 0.01 mg. Cr. (0.005 to 0.1 ppm.).

B. Method for Hexavalent Chromium in Sewage

Hexavalent chromium is unstable under normal sewage conditions, chromates being steadily converted to the chromic state through reduction by hydrogen sulfide, organic matter and other reducing agents. This conversion is greatly accelerated by acidity and, under the conditions of the diphenyl carbazide test for potable waters, the acid introduced by the reagent may drive the reduction process to completion so that a negative chromate test will result even though it was present. This can be overcome by clarification of the sewage and removal of the sulfides with a soluble zinc salt. A test on this clarified solution will give the amount of chromate ion actually present in the sewage at the time the test is made. This test is sensitive to about 0.02 ppm. hexavalent chromium. The decrease in sensitivity as compared with the procedure for water is apparently due to the reduction of chromate ions after acidification by the slightly soluble residual sulfide remaining from the zinc precipitation.

Reagents 1. Standard chromium solution—as given in Method A.

2. Diphenyl carbazide—as given in Method A.

3. Zinc sulfate—saturated solution.

4. Sodium hydroxide—10 per cent aqueous solution.

5. Phenolphthalein—0.5 per cent solution in 50 per cent alcohol.

Procedure: To 100 ml. of the sample, in a 100-ml. tube, add 1 ml. of zinc sulfate solution and 2 drops of phenolphthalein indicator. Add sodium hydroxide dropwise until a slight excess of hydroxide is present, as shown by the pink color of the indicator. Mix thoroughly. Centrifuge, or allow to settle until a clear supernatant liquor is obtained. An aliquot of the clear solution should then be transferred to a 100-ml. Nessler tube and made up to the mark. Hexavalent chromium is determined by the addition of the diphenyl carbazide reagent as in Method A, except that the result obtained is multiplied by the proper factor, based on the aliquot taken. The added volume, due to the addition of zinc sulfate, phenolphthalein and sodium hydroxide, may be neglected unless extremely accurate results are desired.

C. Method for Total Chromium in Water or Sewage

A complete analysis may be desired to show the extent of reduction from hexavalent to chromic chromium, or to determine the total chromium present. In this event, the hexavalent ion and total chromium may be determined and the chromic ion obtained by difference. The analysis for total chromium requires the complete destruction of all organic matter and the oxidation of all chromium to the hexavalent form. This may be accomplished by either wet or dry ashing of the sample to destroy organic matter and reducing agents and subsequent oxidation of chromium to the chromate. The

method for total chromium by wet-ashing follows:

Reagents: 1. Standard chromium solution—as given in Method A.

2. Diphenyl carbazide—as given in Method A.

3. Nitric acid—concentrated.

4. Sulfuric acid—concentrated.

5. Sulfuric acid—1 : 1.

6. Sodium hydroxide—10 per cent solution.

7. Sodium peroxide—fresh.

Procedure: To 100 ml. of the sample add 3 ml. of sulfuric acid and 1 ml. of nitric acid and evaporate to SO_3 fumes. Cool and dilute to approximately 50 ml. Add a slight excess of sodium hydroxide and about 5 g. of sodium peroxide and boil off the excess oxygen. Filter if necessary and make the filtrate just acid with dilute sulfuric acid. Make up to 100 ml. in tall-form Nessler tubes and continue as under Method A.

Summary

Undoubtedly chromium is becoming a problem in other sections of the country due to conditions similar to those described here. It would be advantageous if water and sewage treatment plant operators would investigate any unusual conditions in light of the experiences in Los Angeles. The methods outlined for chromium have given excellent results in the laboratory of the Bureau of Water Works and Supply for the past six months. They have, however, been used principally for potable waters and trade wastes, and it is realized that all possible types of wastes and sewage have not been encountered. It will be appreciated if other analysts, who may try these methods, will exchange experiences with the author. It is hoped that a consensus of opinion thus obtained will finally lead to the adoption of a suitable standard method for the determination of chromium.

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Bubbling Drinking Fountains

By Arthur Parker Hitchens and Oscar A. Ross

BUBBLING drinking fountains, in common with other public conveniences, can be approved only when they meet rigid standards. These standards include factors of design, construction, installation, maintenance, location, service and use. A high proportion of the equipment now employed would be condemned by the application of any of the official sanitary specifications. Certain types of fountains are potentially more dangerous than the common drinking cup, the bowl being used as a cuspidor with the result that pathogenic bacteria are concentrated in the drain pipe. Thus they become reservoirs of infection. At times the bacteria are regurgitated into the bowl and splashed up on the lips of users. This is a significant menace during seasons of prevalence of common colds.

Those fountains in which the supply pipe is surrounded by the drain—or vice versa—for the purpose of precooling, introduce a dangerous cross-connection feature. The finding of tubercle bacilli in the drain pipe of any such fountain merely conforms with deductions any one would be likely to make after some study of these appliances.

An investigation of bubbling drinking fountains was made by the authors to ascertain, by bacteriological examination, whether or not fountains now in use may transmit micro-organisms from one user to another and to what extent they may accumulate bacteria from the air or from users in the course of normal service. Twelve fountains were studied, eight being angle-jet cabinet types with built-in refrigeration units, one an angle-jet wall type without refrigeration and three, vertical-jet types without refrigeration.

Physical Findings

The bowls of the fountains were frequently misused as receptacles for cigar and cigarette butts, chewing gum and sputum. In the season when colds are prevalent, bowls are frequently used as cuspidors with resultant clogging of the drain.

Drainage was found to be consistently inadequate, especially so when waste was found in the bowl or when the fountains were heavily used. Provision for water pressure regulation was also inadequate in all the fountains studied. The pressure fluctuated mark-

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edly, only a trickle of water coming out when the fountains were used continuously.

Guards on the nozzles did not prevent contact with mouths and fingers of users. Splashing occurred regularly, varying in degree with water pressure, drainage and design of bowl. Splashing was seen and felt while the fountains were being used. It was also demonstrated experimentally with the aid of the red pigment-producing micro-organism, *Serratia marcescens.*

Bacteriological Examination

Parts of each fountain were selected for routine culturing, either because they came in contact with water passing through the fountain or because they came in contact with the users. The areas selected were rubbed with sterile wet swabs. These were placed in 10 ml. of sterile salt solution. Samples were planted into various culture media within two hours after they were collected.

The drains had an average bacterial count of 42,000 per ml., approximately 24 times that of the bowl and 50 times that of the nozzle. Dismantling and swabbing the inside parts of the water outlet and inlet of one fountain showed the inlet line to have 6,000 bacteria per ml. and the outlet line, six inches down, to have 7,000,000 organisms per ml. Control on city tap water could not account for such numbers. *Beta* hemolytic streptococci were recovered from every part of all fountains examined, the counts again being higher along the water flow.

To test the movement of purposely inoculated organisms from one part of the fountain to another as well as from fountain to user, the bowl and drain were inoculated with *S. marcescens.* Swabbings showed that bacteria remained from 30 min. to 2 hr. on the inoculated parts. Those in the line of water flow were washed away sooner than those from other parts. In one instance, after the drain only had been inoculated, *S. marcescens* was recovered from the nozzle, although the organism was not found in any of the routine cultures of this fountain.

That splashing is definitely a potential source of infection to users of fountains was shown by inoculating the bowl and drain with *S. marcescens.* Agar plates were held inverted at approximately the position of the face of the person drinking. The water was then turned on for 1 to 2 min. The test organism was found on 14 of 17 plates. In two cases positive "splash" plates were obtained 2 hr. after introducing the organism. The count was always higher when drainage was slow.

From routine cultures and controls it seemed likely that the significant organisms from the fountains were bacteria deposited there by the users. Another study proved that users of a particular fountain, some of them known to be tuberculous, actually deposited tubercle bacilli there. Inoculation tuberculosis was produced in a guinea pig inoculated with the swabbings from the fountain in a waiting room of a dispensary for the diagnosis and treatment of tuberculosis. This fountain was of the older porcelain wall type without refrigeration.

Conclusions

Several standards for the construction of bubbling drinking fountains have been set up in an effort to secure, in these appliances, safe and convenient public dispensers of drinking water. These standards are too fre-

quently ignored. Studies of fountains actually in use as reported here emphasize the need for serious attention on the part of health officers to those fountains so constructed and used that they actually concentrate and distribute agents of disease.

The finding of large numbers of bacteria in the drain pipe means that here is a concentration point for bacteria which find their way into the bowl. Among these are pathogens from the mouths of users. Clogging or partial closure of the drain sometimes occurs well down below the level of the bowl. Then, with slow runoff, bubbles of air come up from deep in the drain and bring with them some of the bacteria which they dislodge. Splashing up of the water in the bowl under such circumstances completes the chain of transmission of bacteria from patrons who used, and misused, the fountain, even hours earlier, to the lips of a present user.

The demonstration of inoculation tuberculosis in a guinea pig from material in the drain, plus the results obtained by purposely inoculating parts of the fountain with *Serratia marcescens,* support the hypothesis that drinking fountains can and do serve as intermediary links in the epidemiological pattern, user-to-fountain-to-user.

Proposed Plan for Water Main Sterilization

By A. N. Heller

In times of peace the problem of sterilizing water mains is one concerned almost entirely with new installations. In times of war an additional possibility is introduced, i.e., the sterilization of mains which may have become polluted as a result of external violence. Furthermore, in wartime, rapid expansion of both military and civilian establishments, often under adverse conditions with speed of construction an essential feature, makes the problem of main sterilization one of paramount importance. The construction of approximately eleven miles of new fresh-water mains in the New York Navy Yard during a recent period led to an investigation of methods of sterilization which would satisfy the following criteria:

1. The water reaching consumers must meet U.S. Public Health Service standards for potability.

2. The usual supply of water to the area concerned must continue during the period of sterilization.

3. The water must be accessible to sanitary test at all times at key points on the distribution system.

4. Excessive wastage of water must be avoided.

5. Excessive use of sterilizing agents must be avoided.

A review of the literature on the subject of water main sterilization and personal questioning of a number of water works authorities failed to elicit a method which would meet these requirements. In discussing this problem, Adams and Kingsbury (1) emphasized the role of oakum packing as a source of recontamination of newly constructed water mains, but did not indicate how this difficulty could be overcome. Calvert (2) attempted to solve the problem by introducing sufficient chlorine into newly laid mains to produce a residual of more than 90 ppm., isolating the line and allowing a contact period up to 43 hr. As a result of his observations he states, "the chlorination of new mains, laid with untreated hemp, is futile. Chlorine appears not to penetrate the hemp and even if it does, the bacteria will grow when chlorine is gone." He suggested the use of a rubber substitute called "Flex-Sani-Pac," swabbing of pipe with "Klerol" and coupling this with heavy doses of chlorine as a possible means of producing a water which would be bacteriologically safe.

A contribution by Ensign A. N. Heller, H-V(S)U.S.N.R., Asst. Industrial Health Officer, U.S. Navy Yard, New York; publication authorized by the Commandant, U.S. Navy Yard, New York. The opinions and assertions contained in this article are the private ones of the writer and are not to be construed as official or reflecting the views of the Navy Department or the naval service at large.

The U.S. Public Health Service (3) recommends the repeated dosage of 50 ppm. chlorine until the affected portions of the mains have been sterilized.

In short, there was a great diversity of opinion as to effective methods of securing proper sterilization, especially within the limitations necessitated by the circumstances involved. As pointed out, it was necessary to accomplish sterilization with no interruption to the normal water supply. This made it impossible to employ the commonly accepted "batch" or "slug" method of chlorination, which often requires repeated shutdowns of from 48 to 96 hr. or longer.*

Procedure Employed

To eliminate this and other disadvantages of the older methods of main sterilization a procedure was adopted which involved the repeated introduction of relatively low chlorine dosages for periods of 24 hr. In actual practice, the technique involved the maintenance of a "free" chlorine residual, determined by the ortho-tolidine flash reaction, of 0.5 to 2.0 ppm. beyond the "break-point" during the 24-hr. period of treatment. This was accomplished by employing a Wallace & Tiernan trailer type emergency chlorinator capable of introducing chlorine solutions at rates as high as 300 lb. of chlorine in 24 hr. against main pressures up to 100 psi. As will be pointed out below it was necessary to repeat this process two to four times before sterilization was complete.

*Arthur Gorman (4) states: "A leak in a main or service connection near a sewer or house drain may go undetected for years, especially in an unmetered system. Should these pipes be drained or a negative head be developed in the water system, sewage might easily pollute the water supply."

The steps in the process briefly were as follows:

1. Flushing out of mains thoroughly for a period of about 1 hr. at the far end of the line and at other key points as required by local conditions
2. Taking samples of water at the intake and key points on system for bacteriological examination and determination of chlorine content
3. Introducing chlorine and adjusting feed to produce "free" chlorine residual of 0.5 to 2.0 ppm. (HOCl), as determined by the ortho-tolidine flash reaction, at numerous sampling points along the system
4. Taking samples for bacteriological examination and chlorine content during chlorination (In practice this was done at numerous intervals, such as 1, 5, 10 hr. after adjustment of residuals to the desired level.)
5. Continuing chlorination for 24 hr.
6. Taking samples for bacteriological examination and determination of chlorine content at the end of $\frac{1}{2}$, 1, 2, 4, 8–10, 24 and 48 hr. after termination of chlorination
7. Repeating the process as often as necessary, if post-chlorination samples are found not to meet standards for potability as determined by the U.S. Public Health Service standards
8. Permitting use of water for all purposes except drinking during the period of treatment.

Results

The procedure as outlined has been followed in sterilizing about ten sections of newly laid fresh-water mains varying in length from 300 to 5,000 ft., in diameter from 4 to 16 in. and in pressure from 30 to 125 psi. In all instances the results have been practically identical. A typical case may be outlined as follows:

Length of Line: 4,000 ft.
Diameter: 16 to 6 in.
Pressure: 100 psi. at point of chlorine introduction, 30 psi. at far end of system.

A. Conditions Prior to Chlorination

1. *Bacterial Flora*

a. Intake (New York City Water Supply): Free of members of coliform group (index less than 2.0)

b. Key Sampling Points (Along Waterlines): Coliform indices greater than 240 at all points (five 10-ml., one 1-ml., one 0.1-ml. and one 0.01-ml. portions all positive for members of coliform group)

2. *Chlorine Content*

a. Intake: Less than 0.05 ppm.

b. Key Sampling Points: Less than 0.05 ppm.

B. Rate of Chlorine Dosage: 15 lb. per 24 hr.

C. Concentration of Chlorine Maintained: 1.0 to 2.0 ppm. free chlorine (HOCl) residuals

D. Time of Application: 24 hr.

E. Conditions After Chlorination

1. *Bacterial Flora*

a. Intake: Index less than 2.0

b. Key Sampling Points: As given in Table 1

c. Reappearance of Coliform Bacteria: See Table 2

TABLE 1

Effect of Low Chlorine Residuals on the Sterilization of 4000 Feet of Water Main *

Key Sampling Point †	Prior to Chlorination		During Chlorination‡		After Chlorination	
	Residual	Index	Residual	Index	Residual	Index
Treatment No. 1						
Midway in System	<0.05	>240	1.0	<2.0	<0.05	8.8
End-Point in System	<0.05	>240	0.5	<2.0	<0.05	5.0
Treatment No. 2						
Midway in System	<0.05	8.8	0.8	<2.0	<0.05	4.4
End-Point in System	<0.05	38	0.5	<2.0	<0.05	8.8
Treatment No. 3						
Midway in System	<0.05	4.4	0.8	<2.0	<0.05	<2.0
End-Point in System	<0.05	8.8	0.5	<2.0	<0.05	<2.0

* Chlorine residual, in ppm., by ortho-tolidine flash reaction, free chlorine (HOCl); coliform index based on "partially" confirmed test through brilliant green bile broth and on 48-hr. samples.

† At *Control Intake,* third sampling point, residual 0.05 and index 2.0 throughout period of treatment.

‡ *Contact Time* throughout was 24 hr.

2. *Chlorine Content*

a. Intake: Less than 0.05 ppm.

b. Key Sampling Points: Less than 0.05 ppm.

c. Disappearance of Chlorine Residuals: See Table 2

From Table 1 it can be seen that in this instance a satisfactory water was obtained after three periods of chlorination. A marked diminution in the degree of contamination was observed even following the first treatment. It was observed that, prior to chlorination, the colonial characteristics of lactose fermenters were predominantly suggestive of *Esch. coli,* whereas the colonial characteristics of lactose fermenters appearing after chlorination were in most cases suggestive of *Aer. aerogenes*. The appearance of organisms of the latter type within 1 to 2 hr. following termination of chlorination, and complete disappearance of chlorine residual in the absence of any demonstrable external source of contamination, led to the theory that the oakum packing in the pipe joints may have been responsible for the aftergrowths. The occurrence of similar bacterial aftergrowths following attempted main sterilization by Adams and Kingsbury (1), by Calvert (2) and by others (3) have led these observers to a similar belief regarding oakum and have emphasized the difficulties introduced by the use of this material. In an attempt to eliminate this complication, observations are at present being conducted on a substitute packing material which, in preliminary laboratory experiments, appears not to possess the undesirable characteristics of oakum, in that it is much less capable of supporting the growth of coliform bacteria. Although no clear-cut outbreak of any of the enteric diseases, in which oakum has been shown to be the source, has been reported, the fact that oakum is able to support the growth of pathogenic as well as non-pathogenic organisms (1) cannot be overlooked.

TABLE 2

Effect of Disappearance of Chlorine Residual on the Reappearance of Coliform Bacteria

Reappearance of Contamination After Chlorination	Hours							
	0	½	1	2	4	8	24	48
Chlorine Residual, *ppm.**	2.0	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Coliform Index†	<2.0	<2.0	<2.0	240	240	240	240	>240

* Ortho-tolidine flash reaction, "free chlorine" (HOCl).

† Data based on "partially" confirmed test, through brilliant green bile broth.

Advantages of Proposed Method

The criteria for a satisfactory method of sterilizing new water mains in a rapidly expanding industrial community such as the New York Navy Yard were outlined at the beginning of this paper. It is believed that the method described satisfies the requirements. A potable water is obtained in one to two weeks, a much shorter period than that reported by others using different methods of sterilization. There is no interruption to the use of water for industrial or sanitary purposes. Complete bacteriological and chemical control can be maintained

throughout the system during the period of treatment. The only wastage of water is that of the initial flushing and a small blowoff necessary to draw chlorinated water through the system. A line of 4,000 ft. required no more than 15 lb. of chlorine for a single operation, or a total cost of chlorine (gas) of less than $4 for the three treatments necessary. There is no possibility that this chlorination procedure will be upset by such things as leakage or the inadvertant opening of faucets or hydrants as is the case when other methods are used.

It was noted above that restrictions were placed on the use of water for drinking purposes during the chlorination procedure as is the case when any other means of main sterilization is employed. This may have been an unnecessary precaution in view of the fact that no members of the coliform group were found as long as a "free" chlorine residual was present in the lines. It was interesting to note that prior to chlorination the predominant forms as suggested by colonial characteristics appeared to belong to the genus *Escherichia,* whereas, after chlorination, members of the *Aer. aerogenes* group seemed to predominate. It remains to be determined by further investigation whether the nature of the post-chlorination flora was a result of chlorine resistance on the part of the *Aer. aerogenes* group of bacteria or whether the new environment was more favorable to the growth of these organisms than to the growth of the genus *Escherichia.*

In the course of the observations connected with the development of the procedure outlined, it was noted that, whenever a "free" chlorine residual even as low as 0.1 ppm. beyond the break-point was present for 1 hr. or more in the distribution system, the water was found to be completely free of coliform bacteria. In addition, there was found to be a marked reduction in non-confirming lactose fermenters. These findings indicated that, under the conditions encountered during this study, the presence of a "free" chlorine residual within the range of 0.3 ppm. beyond the break-point after a 1-hr. contact period produced a potable water.

It should be noted here that satisfactory results were obtained by the use of intermittent chlorination with low residuals under the particular conditions existing at the time of these observations. Just how wide a range of application this method may have must be determined by future observation. It may be that similar results can be obtained when a period of chlorination shorter than 24 hr. is employed. This and other variations in the technique remain to be developed.

The writer wishes to express his appreciation to Lt. Comdr. L. J. Goldwater, MC–V(S)U.S.N.R., Industrial Health Officer, for his invaluable cooperation during the course of this investigation. The writer also wishes gratefully to acknowledge the laboratory facilities provided, without obligation to the Navy, by Dr. H. S. Mustard and Professor E. B. Phelps of the DeLamar Institute of Public Health, Columbia University, New York.

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Water Conservation in Wartime

A Round-Table Discussion

By James H. Allen, R. C. Beckett, H. T. Critchlow, R. I. Dodd and M. J. McLaughlin

Allen: During the course of this round table discussion, we hope to localize your consideration of one of the major problems of water works operation in wartime—the problem of assuring that a sufficient supply of safe water is available at all times for *war* and *essential* civilian needs and purposes.

Early this year, in the Philadelphia Metropolitan District, the three principal water supply agencies servicing more than 90 per cent of the 2,500,000 people in the district foresaw the seriousness of this problem. To meet the situation, a water conservation program was planned and executed. M. J. McLaughlin and R. I. Dodd, who actively aided in the development and management of this campaign will present the highlights of that drive.

In New Jersey, during the months just passed, a basic plan for taking care of that state's water supply requirements, normal and emergency, has been completed and effected. H. T. Critchlow will discuss the features of that plan.

In Delaware, R. C. Beckett has been struggling with water problems that belie the size of his state. He will describe that situation.

As introductory material, I should like simply to state that preliminary explanations regarding the basic importance of water would be superfluous. To relate how an area such as the Philadelphia Metropolitan District, built around the Delaware and Schuylkill River systems, can be threatened with a shortage in water supply would be equally obvious. To illustrate how and why the war needs of homes and industries place abnormal strains upon water supply filtration and distribution systems would be painful to many of you to whom the problem is all too real!

Such phrases as "Water Wins Wars," "Water Is Not as Free as Air,"

A round-table discussion presented on October 8, 1942, at the Joint Meeting of the Four States and New Jersey Sections, Philadelphia, by: James H. Allen, Chief Engr., Interstate Com. on the Delaware River Basin; R. C. Beckett, State San. Engr., Dover, Del.; H. T. Critchlow, Chief Engr., State Water Policy Com., Trenton, N.J.; R. I. Dodd, Exec. Mgr., Chester Munic. Authority Water Service, Chester, Pa.; and M. J. McLaughlin, Chief Engr., Bureau of Water, Philadelphia.

The text has been revised where necessary to adapt it to printed presentation, thus making it more formal than the conversational form in which it was so effectively delivered.

"All Filtered Water Is a Manufactured Product—Use It Wisely," "It's Better to Be Thrifty Than Thirsty," or the more colloquial "Don't Be A Drip" are self-evident to those of you in the profession. But the householder —your customer—faced during the past few months with limited government rationing to equalize commodity distribution and besieged by threats of shortages—actual or imagined—in other goods and services has become confused and skeptical. To counteract that confusion and skepticism, in the Philadelphia Metropolitan District water conservation program, was a public relations jobs of no small proportions —and the stakes were large!

Without further preliminaries, I am going to ask McLaughlin to begin this round table discussion of wartime water conservation by stating facts and figures in behalf of the Philadelphia Water Bureau.

McLaughlin: Before discussing specific facts and figures, I want to place particular stress upon the point which, to my mind, was the greatest single factor in the success of the water conservation program in the Philadelphia Metropolitan District, i.e., the principle upon which the program was founded. As was pointed out in the introductory remarks, early this year those in charge of the three major water supply systems in the Philadelphia district saw trouble ahead during the summer months of peak usage. Demands for water were increasing at an alarming rate. Unless "water-as-usual" habits were curtailed a breakdown seemed inevitable. It was obvious, however, that the answer to the situation was not in the hands of the management, but rather in the hands of the customers.

As was also pointed out, at that time much confusion and skepticism existed regarding the distribution and use of rubber and gasoline. On one day, the people were being told one thing; on the next, something entirely different. We of course, wondered what the reaction would be to a proposal for the conservation of water. After consideration, we decided that if we gave our customers the exact, plain facts and requested their voluntary co-operation in sharing in the solution of the problem, without resort to threats, coercion or compulsion, they would understand and appreciate its seriousness and respond wholeheartedly. That was the fundamental principle upon which the program was founded. The success of the program has proved its soundness.

Beckett: I am glad that McLaughlin has emphasized this method of dealing with the problem of water conservation in the beginning. It confirms not one, but two principles to which most of us subscribe. First, as I understand it, the "water in wartime problem" in the metropolitan Philadelphia area was viewed and treated as a problem common to all of the water supply agencies serving the district, and not, as would have been the custom in the past, as separate individual troubles to be solved entirely independently of each other. To members of this Four States Section of the American Water Works Association, one of the chief purposes of which is to meet to discuss problems of common interest, this approach is particularly gratifying. Secondly, it seems to me, from what has been said thus far, that the success of your program has proved that the people—when given the true facts—can be counted upon to do their part.

Critchlow: Being closer to the scene, McLaughlin and Beckett know the "Philadelphia story" better than I. I certainly agree to the soundness of your approach, but I am not entirely familiar with the problem and know but little about the way it was handled. I am ready to learn more about the details of the program.

Allen: Suppose I state briefly the specific conditions which led to the need for a water conservation program in the Philadelphia area and let McLaughlin and Dodd pick it up from there. Three factors were involved in creating the problem:

1. The tremendous expansion of war industries requiring an ever-increasing supply of relatively pure water for use in their manufacturing processes
2. The accelerated spread of defense housing and war housing developments, which brought thousands of new users to the existing water systems
3. The abnormal increase in home consumption caused both by increased employment and by population increases not taken care of through new housing developments.

Three water supply agencies, the Philadelphia Bureau of Water, the Philadelphia Suburban Water Co. and the Chester Municipal Authority Water Service supply almost the entire needs of the district. These agencies get their water from surface sources, mainly the Delaware and Schulykill Rivers and their tributaries. While these sources provide an abundant supply of raw water, the systems for treating this water, as can well be imagined, were not designed to meet the abnormal increases involved in wartime conditions. Because of prior demands for materials and labor to fight and win the war, increasing the capacity of treatment plants was out of the question. For the duration, the limit on the amount of available water was fixed. As a result there was only one answer—water conservation. McLaughlin will indicate the seriousness of this situation.

McLaughlin: Philadelphia gets its water, in about equal amounts, from the Delaware and Schuylkill Rivers. For many years—a quarter of a century or more—proposals have been advanced from time to time to abandon these sources in favor of an upland supply from the Delaware watershed. Because of the resulting uncertainty as to the continuance of the present sources, the plant was not maintained to the usual desirable standards. In 1939, this question was settled when the voters gave their approval to a $25,000,000 rehabilitation and improvement program. A start had hardly been made, however, before war came and it has been impossible to proceed with the program in accordance with original plans. As a result, the Philadelphia system is not equipped to meet the abnormal demands imposed by wartime conditions.

Before Pearl Harbor the average summertime demand was approximately 335 mgd. The maximum requirements at times amounted to 400 mgd. That is approximately the capacity of the system. In January and February 1942, consumption was about 10 per cent higher than in the corresponding months of 1941. In investigating the situation further, we discovered that industrial use had increased about 25 per cent and that the population of the city was increasing rapidly. A little arithmetic indicated that, if past habits in the use of water were continued, the summertime de-

mand during 1942 would reach an average of 375 mgd. and we might expect maximum demand to reach 440 mgd. In view of the capacity and condition of the plant, it would have been physically impossible to meet these conditions. Briefly, that is Philadelphia's picture. The situation at Chester was not materially different, as will be explained by Dodd.

Dodd: At Chester, we were confronted with the same fundamental problem. Industrial use was soaring; a large number of defense and war housing projects were being constructed in our territory; and thousands of war workers were coming into the area. Except as to filtration plant facilities, however, the system was adequate and in good condition. In 1941, the filtration plant had a reserve capacity of about 20 per cent; but, as in Philadelphia, it required only a little arithmetic to demonstrate that this reserve would be wiped out entirely if normal water-use practices were continued in 1942.

Critchlow: I can easily understand the situation in Philadelphia and Chester. They are very important war production areas similar to some sections in New Jersey, but it is difficult to see how the war involves the Philadelphia Suburban Water Co. to any great extent. Does not that system serve principally the suburban residential areas of Philadelphia?

Allen: It is true that the Philadelphia Suburban Water Co. serves a large suburban residential area, but it has a big industrial business as well. Between Philadelphia and Chester, bordering on the Delaware River, are many industrial communities, all served by this company. The demands in this section have increased substantially and have resulted in difficult operating problems for the company. Its interest and stake in the water conservation program were as important as that of Philadelphia and Chester.

Critchlow: The facts of the situation now are clear to me. Judging from the explanations just given they would seem to sum up as follows:

1. The normal peacetime maximum demands for water in the Philadelphia Metropolitan District are about 440 mgd.

2. The total maximum capacity of the existing water works systems in the area does not greatly exceed the maximum demand.

Two and two make four. If the usual habits of water use continued during 1942, the demands would have exceeded capacities. It is obvious that the only way to avoid such a situation was to reduce the demands in some way. It is equally obvious that this had to apply to wastage and nonessential uses. How was this accomplished?

McLaughlin: I would like to start this explanation by stating briefly, but emphatically, that it was through the efforts of the Interstate Commission on the Delaware River Basin that the water supply agencies were brought together. The commission arranged the series of conferences at which the problem was viewed collectively. Through its guidance, the policy in approaching the public with the plea for conservation was determined and the details of the campaign settled.

Beckett: As a member of that commission, it is nice to know that any assistance we may have rendered is so greatly appreciated.

Let's get back to Critchlow's question. He wants to know how the campaign was carried out.

Dodd: The answer to that goes back to McLaughlin's early remarks. We gave our customers the plain, cold facts and requested them to co-operate by using water wisely. We suggested a few ways in which they could help:

1. By using what water they needed, but no more
2. By prompt repair of leaking plumbing fixtures
3. By curtailing garden and lawn sprinkling
4. By developing and practicing the habit of water-watchfulness.

Critchlow: That's fine but how did you bring these messages home to the people?

McLaughlin: By a concentrated campaign conducted through the press, radio, civic organizations and civilian defense agencies. For three weeks in May, every effort was made, through all available media, to bring home the facts of the emergency. Some 750,000 four-page leaflets, outlining the facts in the water emergency and suggesting ways of avoiding water wastage and curtailing non-essential uses, were prepared and printed for distribution to every home in the District.

The Philadelphia Metropolitan District Council of Defense, composed of the five county councils in the area, welcomed the opportunity to assist in the campaign and agreed to use their organizations for the distribution of these leaflets. Thus, every one of the 750,000 homes in the district was circularized, a majority through the efforts of a neighbor volunteer in the Air Raid Warden Service.

Also, 80,000 printed posters, 20,000 each of four designs were displayed in public places and in industrial plants. These posters were varied to suit the particular needs of the different sections of the district. For example, the careless waste of water through leaking fixtures was featured by the poster colloquially headed "Don't Be A Drip!" In suburban Philadelphia, where the largest source of water wastage and luxury usage occurs through the excessive use of hoses for lawn and garden sprinkling, a poster, featuring a hose, was inscribed "Water for Grass—Or Water for Tanks and Guns?"

Dodd will describe the newspaper and radio coverage.

Dodd: We received the full cooperation of both newspapers and radio. Through the press, both metropolitan dailies and suburban weeklies, the public was kept fully informed. News stories, editorial comment, features and cartoons, prepared or stimulated centrally, were used.

The patriotic participation of Philadelphia's radio stations was particularly helpful. Fourteen radio addresses and round-table discussions were "aired," during the concentrated campaign period, on free time furnished by the major radio outlets. The Mayor of Philadelphia opened the radio campaign with the keynote: "Here and abroad, on land and on sea, at present as in the past, Water Wins Wars!"

Critchlow: I notice that all of the posters, and I am sure the newspaper and radio programs, were directed to the folks at home. From my observations, municipalities are one of the greatest offenders in wasting water and using it needlessly. In summertime many of them are prodigal in their use of water for street sprinkling

and neighborhood showers. Philadelphia, I believe, has quite a reputation in this regard.

McLaughlin: Prior to this year, we did have such a reputation; but, realizing that the water conservation drive would be extremely vulnerable to legitimate criticism unless public agencies took the initiative to save water, this year we took extra precautions to save water in every way. Street sprinkling and showers were discontinued entirely. Orders were issued to examine all water outlets and to repair any leaks immediately. Hydrant and valve inspections were increased; underground leak and waste surveys were intensified. All governmental employees were urged to practice conservation measures both at work and at home.

Dodd: To that we might add that industrial water wastage was recognized to be fully as important as domestic and municipal abuses and also that printed notices urging the cooperation of guests were placed in every hotel room throughout the city.

Beckett: To summarize, during the period of the campaign, you carefully told the story by every available method. What were the results?

Allen: The results were most encouraging. They show that the vast majority of the water consumers in the district responded, patriotically, to the appeal to conserve water for *war* and *essential* civilian needs and services.

From essential water requirements last year, as you will recall, it was estimated that the demands in Philadelphia would have been at least 40 mgd. more than normal. The city not only met that increased demand for essential needs but did it with an average of 20 mgd. less than was used the previous year. This means that, as a result of the conservation program, 60 mgd. of water previously wasted or used for non-essential purposes were saved to meet wartime requirements.

Dodd: We made comparable showing in Chester. In 1942, during the peak period of demand, we used about 15 per cent less water than in 1941. Without conservation, an increase of at least 20 per cent could have been expected.

That does not mean, of course, that the job is completed. War production still is on the increase. The practice of thrifty water use by every agency and person must go on. Only in this way can an increasingly severe strain on the water systems of the Philadelphia Metropolitan District be avoided, with all of the risks attendant upon breakdowns in mechanical equipment and resultant inadequacies in water supply for wartime needs.

Allen: I am sure that it will be agreed that the water conservation program in the Philadelphia Metropolitan District was a success. It has proved to be a very practical way to meet a very difficult problem. However, we have not given our associate from New Jersey an opportunity to tell us how the wartime water supply problems were handled in his bailiwick. What has been done in New Jersey, Critchlow?

Critchlow: New Jersey has taken steps, by the passage of an Emergency Water Supply Act, to assure, so far as possible during the war emergency, an uninterrupted supply of water primarily to those communities in which war industries are located. Since, for

the duration of the war, it will be impossible to develop additional sources of water supply, it is vital that the existing sources of supply be utilized to the fullest extent.

The program inaugurated under the emergency legislation consists of ordering certain inter-connections between public water systems for two main purposes: (1) to provide an emergency supply in the event of an interruption of the supply in either system so connected; (2) to transfer water from a system which may have a surplus to a system which has a shortage, in order to conserve the water for a future period of deficiency.

Under the legislation, new inter-system connections may be ordered after a hearing. To date, a total of seventeen have been ordered, twelve in the northern metropolitan district, consisting of the six northeastern counties just west of the Hudson River, opposite New York City, and five in the southern metropolitan district, defined approximately as the Camden Area.*

If an inter-system connection benefits only the municipalities connected, the cost is borne by the municipalities. Where it benefits a territory beyond the systems immediately connected, the state may pay a portion of, or even the entire, cost. The estimated cost of inter-system connections ordered or completed to date is $111,000. The volume of water interchangeable through them is 96.7 mgd. The state will pay approximately $63,000 and the municipalities and water companies approximately $48,000.

Through certain existing inter-system connections, and one new connection ordered by the commission, it was possible to conserve 3.4 billion gal. of water in the Wanaque Reservoir, which was only two-thirds full at the beginning of 1942. This was accomplished by transferring water from two other water supply systems which had a surplus going to waste.

Another step taken under the emergency legislation has been to set up a plan for the joint operation of certain public water supply systems in metropolitan areas. A joint board of five water works officials, has been appointed by the State Water Policy Commission to work out a plan of operation in case of an emergency in the northeastern metropolitan district. This plan will be designed to assure, so far as possible, a supply of water to areas which may have their source of supply cut off through sabotage or bombing attack, or from any other cause.

It is believed that this inter-system connection and joint operation program will make it possible to meet any reasonable need which may arise during the war. If the rate of consumption should increase beyond the total capacity of the water supply systems, it may be necessary to ration the water.

Allen: Although water works men appreciate the value and importance of water in wartime, may I, nevertheless, close this round table discussion with a summary statement included in a recent radio address by the Chairman of the Interstate Commission on the Delaware River Basin, the Honorable Ellwood J. Turner:

"Water is an *offensive* and *defensive* weapon of warfare *here and everywhere* in the world.

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* EDITOR'S NOTE: A detailed review of this subject presented by Mr. Critchlow at the 1941 A.W.W.A. Convention was published in the September 1941 JOURNAL (**33**: 1517 (1941)).

"As an offensive weapon, of most importance, water maintains public health so that war activities on the home front can be actively geared to far-off battle fields; water provides protection against the spread of destructive fires which would seriously cripple the progress of domestic participation in the war effort; water is vital to war production, in the building of ships and tanks, guns and planes, in *every* industrial process!

"As a defensive weapon, water, in modern warfare, is the basis of our civilian protection organization. All that is being done through the civilian defense auxiliary agencies to protect your life and property from the destructive effects of enemy attacks by air, would be nullified if—when the emergency comes, *as we must expect that it will*—adequate supplies of water are not readily available.

"Constructive planning for the *worst,* instead of wishful thinking for the *best,* is the order of this and every coming day.

"That planning assumes, as an essential foundation, the effective maintenance and operation of the *one basic* utility which guards the health, safety and welfare of every citizen—the water works system. . . ."

Water Supply Development for the Army

By Frank V. Ragsdale

THE problems of water supply development in wartime are not much different from those at any other time. The difficulties are the same and the results desired are the same. When the Army wants water, it goes about getting it by much the same means as used by any other body of consumers in times of peace.

Many times, you water works men have already solved a major part of the problem for Army Engineer Corps. You have developed a dependable supply of good water and we simply tie onto your mains. That leaves only the distribution problem up to us. But more often your mains are not at hand or cannot carry any further load. Then we have to provide the water.

The problem then is still a peacetime problem, but we can seldom solve it in the peacetime way. The weeks, months and even years that calmer times allow for planning must be contracted into hours and days. Water is still where you find it *but we must find it a whole lot more quickly*. Development of the supply must follow very closely, and almost catch up with, the planning.

Reservoirs are usually out of the question because the time element is against their proper development and use. Streams or lakes with usable waters are seldom available and their development may be very slow due to critical materials required for purification machinery.

Fortunately, ground water supplies are available over a large part of the country. Finding and properly developing them is in most cases the best and by far the quickest thing to do in these times. Water may thus be quickly supplied to some small isolated post or to a large camp or industry. Frequently an industry can be located at the known water supply, but the military needs must usually be obtained at a definite location. When we of the Engineer Corps cannot find water, and find it quickly, life becomes very uncomfortable.

Finding underground water remains a matter for geologists, geophysical experts and experienced old-time well drillers. Frankly, we have had more luck with the old-timers than with anyone else. I am not talking about willow-stick cranks or anyone of that sort, but about the men and companies who have grown old in well drilling and can readily use the wisdom of their experience. A few interesting, though not necessarily characteristic, developments will illustrate this.

A paper presented on October 29, 1942, at the California Section Meeting, Oakland, Calif., by Frank V. Ragsdale, Lt. Col., Corps of Engineers, San Francisco; published by permission of the Division Engineer, U.S. Engineer Office.

Somewhere in California, in an isolated location, a small dependable water supply was urgently needed. It was in the vicinity of a very small mountain whose sides were wet in many spots by small springs or seeps. Everything pointed to the probability of finding a little water by drilling a well most anywhere around the slopes. That is what we tried. The materials encountered in drilling were right; in fact, everything was right except the water, which just did not appear. Hauling water over long distances and up steep grades appealed less and less to the troops as time wore on; so a well was drilled in the top of the mountain, and they have not had to haul any water since. I could go into a long explanation of the *after-the-fact* geological reasons for that being a good well; but it still holds true that water is where you find it.

An adequate water supply was needed for a very large camp. A complete survey was made, reports were written, and then expert consultants wrote some more reports. Wells were drilled and water was found, but the supply was never quite sufficient and the quality left something to be desired. More experts reported and specifically ruled out of all consideration one area near the camp site. As a last resort, however, somebody took a chance and drilled there. A very large supply of excellent water was found and there is no longer any grumbling from that camp! It is not intended to belittle geologists; they are right most of the time; but it is more fun to talk about the exceptional cases.

The distribution problem is also about the same in wartime; but, again, the plans are made almost overnight and the work must keep up with the plans. Today's mistake in planning cannot be corrected tomorrow by making an erasure on the tracing—more likely some pipe will have to be excavated. I am not inferring that mistakes are not made; some are, but not nearly as many as the circumstances would seem to warrant.

The quality of the water supply is carefully investigated. Peacetime standards of purity are not relaxed. The same kind of health officers and the same kind of bacteriologists are on the job. They just check a little oftener and protest a little louder when they find anything wrong.

Fire protection is adequately provided, even sometimes when it would be less expensive to let some things burn up. However, a fire would, in most cases, cause disastrous delay and interruptions, and time is highly valuable nowadays and is a very considerable factor in deciding when to provide fire protection—and how much.

After the war is over and it is found that certain water distribution systems are built of cast-iron pipe, wrought-iron pipe, wrapped steel pipe and possibly a little wood pipe as well, some of you are going to be saying: "Somebody sure got all tangled up during wartime." You'll be wrong on that one. We will simply have taken the available materials and supplied the water where it was wanted, when it was wanted.

Some of you A.W.W.A. members have helped us with our procurement problems. We have used your reserve supply of materials as a reservoir upon which to draw in emergencies. You have done a good job, you have been generous and co-operative. As a member of the Corps of Engineers, I want to thank you for it, but promise we will draw on you again.

Organization and Activities of the Subcommittee on Water Supply of the California State Council of Defense

By Charles Gilman Hyde, Harry Reinhardt and Murray R. MacKall

THE Subcommittee on Water Supply of the Committee on Transportation, Housing, Works and Facilities, California State Council of Defense, was appointed on January 1, 1942, by Frank W. Clark, Director of Public Works, State of California, and Vice-Chairman of the State Council of Defense, acting in behalf of Governor Culbert L. Olson, Chairman of the California State Council of Defense, and Baldwin M. Woods, Chairman of the Committee on Transportation, Housing, Works and Facilities.

The Subcommittee on Water Supply is composed of twelve members, selected, as explained by Mr. Clark, to represent "public utility water companies, and municipal water works in northern and southern California, irrigation districts, mutual water companies, state and federal public health officers, the State Engineer, the Board of Fire Underwriters of the Pacific and the California Railroad Commission." The members are: Charles G. Hyde, Chairman; Harry Reinhardt, Vice-Chairman; Murray R. MacKall, Executive Secretary; Loren S. Bush, Nelson A. Eckart, Cornelius P. Harnish, Harry B. Hommon, William W. Hurlbut, Edward Hyatt, Roy V. Meikle, J. J. Prendergast and Edward A. Reinke. Baldwin M. Woods, as Chairman of the Committee on Transportation, Housing, Works and Facilities, is an ex-officio member of the subcommittee.

In making the committee appointments, its function was outlined by Mr. Clark as follows: "It will be the function of the committee to consider all questions of water supply relative to the present emergency and to recommend to the proper authorities steps which should be taken to insure an adequate water supply for defense purposes at all times."

Problems Facing the Committee

In general the problems facing the committee are those concerned with the implementation of the duties outlined or implied in the statement of function. More specifically, the committee is concerned with the problems which are inherent in the proper and

A paper presented on October 30, 1942, at the California Section Meeting, Oakland, Calif., by Charles Gilman Hyde, Prof. of San. Eng., Univ. of California, Berkeley; Harry Reinhardt, Vice-Pres., California Water & Telephone Co.; and Murray R. MacKall, Hydr. Engr., State of California Railroad Com. The three authors are, respectively, Chairman, Vice-Chairman and Executive Secretary of the Subcommittee on Water Supply of the California State Council of Defense.

adequate execution of the Mutual Aid Plan as developed in the National Office of Civilian Defense and as further conceived and elaborated by the committee itself.

The committee is seriously addressing itself to the solution of the many problems which confront it in relation to defense against sabotage and enemy action, such as bombing, and to the prompt repair of any damage sustained from whatever cause, so that the citizens of the state and critical industries shall not be deprived of their water supply for dangerously long periods, if at all. Obviously, all problems center around the single objective of maintaining the water supply in adequate volume and under sufficient pressure at all times, even under adverse conditions.

Among the particular problems which the committee has met or is facing are the following:

1. Organization of operating committees, so-called, to handle specific phases of the general problem
2. Organization of the state into twelve zones, each under a carefully selected efficient zone leader to carry out the details of the Mutual Aid Plan and all special instructions of the Office of Civilian Defense and of this committee
3. Co-ordination of the work and activities of this committee with those of other committees and agencies—federal, state, county, district, municipal, private, etc., including such organizations as the A.W.W.A.
4. Determination of the critical water supply systems as related to the war effort and a study of the vulnerable features thereof with a view to their amelioration or elimination
5. Determination of the feasibility of inter-connections between adjacent water works systems (inter-system connections) with special reference to dual types of sources of supply (gravity *vs.* pumping, i.e., surface *vs.* ground waters) or dual sources of power (central station electric *vs.* locally generated electric, employing internal combustion engines, or *vs.* a duplicate central station source)
6. The development of suitable and sufficiently comprehensive inventory forms and the compilation of inventories of supplies, materials and equipment in the water works of the state
7. The pooling of such supplies, materials and equipment in self-contained areas for the purpose of securing their immediate availability within such areas should excessive damage occur by reason of sabotage or enemy action
8. The study of priorities with relation to supplies, materials and equipment needed for water supply extensions and emergency repairs
9. Development of pools of skilled labor to function if excessive emergency repairs are necessary
10. Selection, identification and training of water works personnel for emergency and guard service
11. The guarding of the vulnerable features of water supply systems by federal, state and local agencies
12. The determination and delineation of areas, features and works which should be defined and decreed to be restricted areas as related to trespass by unauthorized persons, and the certification of these areas or zones to the proper military and civil authorities
13. Study of manpower depletion by selective service and by war industries, and the maintenance of adequate staffs of trained and experienced operating personnel for vital water supply works and for public water supply works in general

14. Study of farm water supplies as related to failures due to power shortage or damage and as available to evacuees

15. Determination of the availability of public water supplies along possible evacuee routes

16. Camouflage of vital features of water works systems

17. Investigation of the extra-territorial rights and the legal protection of water works personnel in the event of widespread damage in multiple water supply areas

18. Development of desirable or necessary further legislation to promote the effective execution of the essential activities represented by the work of this committee in the event of a prolonged conflict

19. The dissemination of information concerning the duties and activities of water works personnel under emergency conditions.

The matters of water quality, its determination and maintenance, and of the effects of sewerage and sewage treatment works, particularly with reference to stream and water source pollution by reason of sabotage and enemy action, have been left with the Bureau of Sanitary Engineering of the State Department of Public Health where they normally repose. The Bureau has the necessary authority and equipment to perform this service.

Furthermore, the matters of fire protection and fire fighting are considered to be without the jurisdiction of this committee, because, under the organization of the State Council of Defense, these undertakings have been assigned to the Civil Defense Committee in collaboration with the Bureau of Trade and Industrial Education of the State Department of Education. It is manifestly the duty of the Subcommittee on Water Supply and of all water supply personnel in the state to maintain at all possible times an adequate supply of water at all hydrants and other fire service outlets.

Formal Meetings of Committee

To date, five regular meetings of the entire committee have been held—three in the State Building in San Francisco and two in the State Building in Los Angeles. It is the practice to alternate the meetings between the north and the south.

These meetings have been very well attended, not alone by the members of the committee itself, but by members of the several operating committees and by zone leaders as well. Considering the long distances of travel, this fact is very encouraging and attests to the loyal and lively interest in vital problems which all concerned are exhibiting.

The matters considered by the committee are represented in part by the list of problems facing the committee, as above outlined. Others will appear from the following discussion.

Complete minutes of the meetings are kept by the Executive Secretary and sent to all members of the committee and to other interested persons who are entitled to receive them.

Caucuses of Local Members

With such a wide distribution of membership, it has been impossible to call meetings of the entire committee at frequent intervals. To prepare the agenda for the regular full committee meetings and to obtain group opinion on matters requiring prompt action, it has become a policy to hold caucuses of local members. Minutes of all such meetings are prepared and sent to all committee members and to such others as are rightfully concerned.

The caucuses held to date and the principal subjects of discussion have been as follows:

February 4, 1942, at San Francisco, 11 persons present, to consider the extent of jurisdiction, authority and responsibility of the Subcommittee on Water Supply, meeting with Attorney General Earl Warren.

February 10, 1942, at San Francisco, 10 persons present, to consider the proper functions of the Subcommittee on Water Supply and the organization of Operating Committees for presentation to the then forthcoming regular meeting of the entire committee in Los Angeles on February 20.

March 12, 1942, at San Francisco, 9 persons present, to discuss the propriety of appointing a State Water Supply Co-ordinator in agreement with the Mutual Aid Plan as developed and recommended by the U.S. Office of Civilian Defense; * the appointment of additional operating committees; and the feasibility of dividing the state into zones with appointed Zone Conference Leaders.

March 17, 1942, at San Francisco, 7 persons present, to consider further the matter of state zoning and the undertaking of an inventory of all water works supplies, materials and equipment which might be available in local areas in the event of widespread damage.

July 13, 1942, at San Francisco, 10 persons present, to consider the establishment of restricted areas, to be closed to the public, around vital water supply works or particular elements of such works; also to review the progress of the studies being made of water supply and service in critical areas; and to discuss the problem of interconnection of vital water supply systems in the Los Angeles area.

August 24, 1942, at San Francisco, 8 persons present, to discuss what action should be taken relative to the letter of August 7, 1942, from Harry E. Jordan, Secretary, American Water Works Association, concerning an inventory of surplus stocks of material held by the larger water utilities throughout the state.

Other Meetings

The Subcommittee on Water Supply has been represented by its Executive Secretary and other members at all meetings of the State Council of Defense, these having been held to date in San Francisco, Los Angeles, and Fresno. Progress reports covering the major activities of the committee have been prepared by the Executive Secretary for presentation to the State Council of Defense through Baldwin M. Woods, Chairman, Committee on Transportation, Housing, Works and Facilities.

The various operating committees have held meetings to further the work which they have been appointed to perform. Also, in the several zones, at the call of Zone Leaders, conferences have been held to acquaint personnel with their particular functions and duties under emergency conditions.

Organization of Operating Committees

Shortly following its organization. the Subcommittee on Water Supply adopted the policy of performing a significant portion of its work through operating committees, so-called. Up

* Protection and Maintenance of Public Water Supplies Under War Conditions. Medical Div. Sanitary Engineering Bulletin No. 1, U.S. Office of Civilian Defense, Washington, D.C. (OCD 3030, Sept. 1942).

to the present time, seven such committees have been appointed and are functioning. Their accomplishments will be related in the following discussion. The personnel of these committees has not been confined to the membership of the Subcommittee on Water Supply. The duties of these several committees are quite definitely implied by their titles.

These Committees and their personnel are as follows:

1. *Critical Water Supply Systems, Hazards, and Emergency Protection*
   Arthur D. Edmonston, *Chairman;* Loren S. Bush, Burton Grant, Cornelius P. Harnish, George Hunt, Edward A. Reinke, William Stava
2. *Jurisdiction, Liaison and Co-operation With Federal, State and Local Organizations and Authorities*
   Edward Hyatt, *Chairman;* Gerald E. Arnold, Harry B. Hommon, William W. Hurlbut, Murray R. MacKall, Harry Reinhardt
3. *Water Supply Needs, Including Special Equipment*
   Harry Reinhardt, *Chairman;* Loren S. Bush, Carl M. Hoskinson, Morris S. Jones, John S. Longwell, Fred A. Rhodes
4. *Water Works Personnel*
   Roy V. Meikle, *Chairman;* Nelson A. Eckart, Andrew L. Gram, A. I. Kelley, Clayton B. Neill, J. J. Prendergast
5. *Priorities*
   Murray R. MacKall, *Chairman;* Nathan A. Bowers, W. R. Foster, Robert C. Kennedy, Charles T. Leeds, Carl F. Mau, L. E. Northrop, A. M. Rawn
6. *Dissemination of Information From Committee to Essential Organizations and Authorities*
   Charles G. Hyde, *Chairman;* Raymond F. Goudey, Warren Olney, Edward A. Reinke
7. *Legislation*
   Warren Olney, *Chairman;* Edward Hyatt, Murray R. MacKall.

Contributions of State and Private Agencies and Personnel

The work of this committee could not be conducted if it did not have the generous co-operation of existing state agencies and personnel and that of the other public and private organizations represented in the membership of the main committee, its operating committees, and the zone leaders. All of these agencies and organizations have not only donated the time of their representatives, but have also met the travel and other expenses incident to this public service. In some instances these contributions have been very large, measured in terms of effort, time and money.

The State Railroad Commission has freely permitted the use of its quarters in the state buildings in San Francisco and Los Angeles for the holding of meetings. It has assigned several members of its staff to the work and has furnished the funds and equipment involved in the very large amount of correspondence, minutes and instructions incident to the committee's work. A significant proportion of the service of the Executive Secretary and of other members of the Hydraulic Division has been devoted to this task.

The State Department of Public Works, through the State Engineer and members of his staff, has devoted an immense amount of time and has met no small expense in conducting

certain phases of the work of this committee, particularly the work of Operating Committee No. 1 on Critical Water Supply Systems, Hazards and Emergency Protection.

The State Department of Public Health has assigned its Senior Sanitary Engineer wholly to the work of Civilian Defense, including very especially the activities of this committee. It has already placed in the field three expert sanitary engineers as regional water works advisers whose sole duty relates to the program of this committee, plus the maintenance of water quality, emergency sewerage protection and certain other special phases of civilian protection. Steps are being taken to secure two additional members for the Regional Water Works Advisory Staff.

The committee is deeply indebted to the Agricultural Extension Service, College of Agriculture, University of California, for its valuable contribution of personnel and expenditure involved in an Emergency Farm Water Supply Project aimed at the protection and maintenance of farm water supplies under emergency conditions looking to their continuous availability for local domestic purposes, to their possible use by evacuees, to the watering of stock and to the extinguishment of incendiary fires.

Activities of Operating Committees

As previously noted a large part of the work of the Subcommittee on Water Supply has been delegated to operating committees selected to work on specialized subjects.

Committee No. 1, on Critical Water Supply Systems, actually had its inception in the studies started by the State Engineer, the Hydraulic Division of the State Railroad Commission and the Bureau of Sanitary Engineering of the State Department of Public Health, prior to the organization of the Subcommittee on Water Supply. These subdivisions of the state government foresaw the need of compiling vital information relative to the whole subject of water supply storage and distribution and were actively engaged in the various phases of the work when the Subcommittee on Water Supply began its deliberations. The work of this operating committee was placed in the hands of Arthur D. Edmonston of the State Division of Water Resources as chairman and the reports that have been completed by his staff and the members of his committee are of tremendous value to the water departments concerned as well as to the military. It must be remembered that this work is of a highly confidential nature, so that a person not directly connected with the industry or service reported upon may never hear about what is being done. One may be assured, however, that the results will manifest themselves in improved water supply conditions in the critical areas of the state.

Committee No. 2, on Jurisdiction, Liaison and Co-operation With Federal, State and Local Organizations and Authorities, was placed in charge of State Engineer Edward Hyatt as chairman. This committee has held several meetings to organize and outline the work that will have to be done as the occasions arise and will be the channel through which most of the vital work being done by the Subcommittee on Water Supply reaches its proper place in the federal and state governments. When necessary this committee will be called upon to aid in working out the financing of projects sponsored by the Subcommittee on Water Supply.

Committee No. 3, on Water Supply Needs, Including Special Equipment, was placed in the hands of Harry Reinhardt as chairman. This committee has held meetings on various occasions and has co-operated at the meetings of other committees. Its first studies were concerned with the various mutual aid plans then in effect in other states and in designing a plan to fit the California situation. As a result, the state has been zoned and zone meetings have been held to put into effect the mutual aid plan. Committee members have attended zone organization meetings and have been ably assisted in their work by the state departments mentioned above. Once this phase of the work is completed, it then becomes the duty of the zone leader to complete his organization and keep it functioning. One of the first duties of the zone leader is to inventory the personnel and equipment in his zone; and thereafter he will carry on the administration in accordance with conditions as they are presented. An inventory form for personnel and equipment was designed by Committee No. 3 after consulting various publications and authorities on the subject. The prepared form appeared to be satisfactory and was reproduced and sent out to zone leaders for distribution and completion. Zone leaders were told to advise the operators in their zones that the inventory was confidential and that only the zone leader and the subcommittee would know the contents. This inventory is still confidential and its uses should not be confused with the inventory of surplus materials for sale, being requested by the government.

Committee No. 4, on Water Works Personnel, was placed in charge of Roy V. Meikle as chairman. This committee has produced a very comprehensive report. Briefly, this report covers the study of the character of employees, the manner of their selection, their morale and the methods by which their efficiency may be maintained. Of special note is the section devoted to the development of a pool of emergency workers and their training to function under the adverse conditions under which they will be called. The section dealing with the employment and training of guards contains a warning on the selection of men to act as guards and the means to be used in their selection. It recommends that, after guards are selected, they should be very carefully instructed in their duties and should be trained in the use of firearms. The report concludes with a section on identification of employees and the issuance of identification and pass cards and a suggestion as to the posting of property and exclusion of all but authorized persons from water works property. This report is in detail and persons interested should obtain copies from the Executive Secretary of the Subcommittee on Water Supply.

Committee No. 5, on Priorities, was placed in the hands of Murray R. MacKall as chairman. This committee experienced difficulties from the very start for the reason that the priorities situation has changed so rapidly that no one could keep up to date on the new orders, administrative letters and interpretations. The American Water Works Association has performed a real service in running down priorities matters and distributing the information to its members. This committee investigated the apparent discrimination in the issuance of priorities and priority ratings, but it was found that this condition was merely a matter of the degree of thoroughness or the tech-

nique which the applicant used in filling out and presenting the necessary data. Much of the deliberation of Committee No. 5 has been on the subject of obtaining and disseminating information concerning the exposure of the Pacific Coast States to enemy attack. This matter has been the subject of resolutions that have been presented to proper authorities with the object in view of relieving, if possible, some of the restrictions as to inventories. The water works field is still confused on the subject of priorities and, except for the efforts of the A.W.W.A., is far behind times in its information concerning such things as administrative letters and limitation orders. This committee has held meetings on the matter of obtaining and handling inventories of surplus materials that are to be offered for sale or use by those in need of them and it is hoped that everyone will soon be better informed on the subject and that the services of the committee will be utilized.

Committee No. 6, on Dissemination of Information From Committee to Essential Organizations and Authorities, is in charge of Charles Gilman Hyde as chairman. This committee deals with the results of the deliberations of the various committees and reviews their reports with reference to the dissemination, to the public and other interested parties, of the information compiled. Since much of the work of the committees is confidential in nature, practically none of its deliberations get into the press, but the available information is always distributed to persons and organizations concerned with the work that is performed by the committees. The major work of this committee thus far has been in compiling and circularizing instructions to zone leaders and plant managers. The instructions have accomplished much in clarifying in the minds of zone leaders and others, the objectives of mutual aid.

Committee No. 7, on Legislation, under the leadership of Warren Olney, has had very little to do thus far, but, with the assembling of the State Legislature next year, there may be requested additional legislation in the matter of extra-territorial activities for municipal services; also the matter of employee and employer liability and compensation for civilian defense workers will be explored.

All committees have functioned in accordance with the immediate needs of the war situation as it has developed. Therefore, some have necessarily been more active than others, but, as time goes on, each committee will develop into full activity and do its share of the work expected of the Subcommittee on Water Supply of the State Council of Defense.

Organization of Zones

To expedite the work of the committee in unifying water works operations and in co-ordinating their activities for defense against sabotage and war action, it was decided to divide the state into a number of zones, with a leader in charge of each zone. This problem was handled by Operating Committee No. 3, as noted.

This committee made a study of the state, finally dividing it into twelve zones. Each zone was bounded by county lines and originally included from one to nine counties, depending upon such factors as natural physical barriers, distances and a consideration of the spirit of co-operation existing between various counties. It was found in some instances that dis-

tances, mountain ranges and unfriendly feeling between certain counties would hamper the co-operative effort sought to be cultivated in the zone and it became necessary to arrange the combination of counties accordingly. It was eventually found advisable to divide Zone 1, comprising eight coastal and Bay counties, extending from San Francisco Bay to the Oregon Line, into two zones, 1-A and 1-B, and to combine Zone 1-B, comprising six southern counties—Lake, Marin, Mendocino, Napa, Solano and Sonoma—with Zone 2 in order that it might be administered in connection with the San Francisco Bay Region Metropolitan Defense Council. This organization consists of nine counties in the vicinity of the Bay region. It was formed for the purpose of providing mutual aid in the area between fire departments, police forces and medical services. Water works, being so closely allied to fire fighting, were considered a logical and necessary additional element for the Metropolitan Defense Council. Los Angeles County was set up as a zone by itself, as it has some 373 water systems within its boundaries and had an organization already formed and functioning for the purpose of furnishing co-operative disaster relief to the water systems.

Description of Zones

Following is a brief statement concerning each zone, giving the name of the leader, the number of counties in each zone, the 1940 census population in the zone and the number of each class of water utility operating in the area:

Zone 1-A: This zone is now under the temporary zone leadership of R. L. Coupal of the Eureka Munic. Water Dept. The counties included are: Del Norte and Humboldt. The total population of the two counties is 50,500. There are 20 water utilities listed in the zone, of which 15 are privately owned, 4 publicly owned and 1 a mutual company.

Zone 2: This zone now includes Zone 1-B and has been reclassified to cover the area of San Francisco Bay Region Metropolitan Defense Council. The zone leader is John L. Longwell, Chief Engr. and Gen. Mgr. of the East Bay Munic. Utility Dist., with headquarters at Oakland. The zone includes the following counties: Alameda, Contra Costa, Lake, Marin, Mendocino, Napa, San Francisco, San Mateo, Santa Clara, Solano and Sonoma. The total population of the eleven counties is 1,770,200. There are 156 water utilities listed in the zone, of which 91 are privately owned, 49 publicly owned and 16 mutuals.

Zone 3: The zone leader is Clayton B. Neill, Div. Mgr., California Water & Telephone Co. with headquarters at Monterey. The zone includes the following counties: Monterey, San Benito and Santa Cruz. The total population of the three counties is 129,500. There are 40 water utilities listed in the zone, of which 25 are privately owned, 6 publicly owned and 9 mutuals.

Zone 4: The zone leader is Delbert D. Smith, Supt. of the Water Works Dept., City of Santa Barbara, with headquarters at Santa Barbara. The zone includes the following counties: San Luis Obispo, Santa Barbara and Ventura. The total population of the three counties is 173,500. There are 103 water utilities listed in the zone, of which 23 are privately owned, 9 publicly owned and 71 mutuals.

Zone 5: The zone leader is William W. Hurlbut, Bureau of Water Works & Supply, with headquarters at Los Angeles. The zone comprises Los

Angeles County. The total population is 2,785,600. There are 373 water utilities listed in this zone, of which 60 are privately owned, 52 publicly owned and 261 mutuals.

Zone 6: The zone leader is J. J. Prendergast, Pres. and Gen. Mgr., Bear Valley Mutual Water Co., with headquarters at Redlands. The zone includes the following counties: Orange, Riverside and San Bernardino. The total population of the three counties is 397,400. There are 419 water utilities in the zone, of which 47 are privately owned, 31 publicly owned and 341 mutuals.

Zone 7: The zone leader is Chester Harritt, Chief Engr. and Gen. Mgr., La Mesa, Lemon Grove and Spring Valley Irrigation Dist., with headquarters at La Mesa. The zone comprises Imperial and San Diego Counties. The total population of the two counties is 349,100. There are 38 water utilities listed in this zone, of which 8 are privately owned, 18 publicly owned and 12 mutuals.

Zone 8: The zone leader is Beecher Rintoul, Supt., Western Water Co., with headquarters at Taft. The zone includes the following counties: Inyo, Kern, Kings, Mono and Tulare. The total population of the five counties is 287,400. There are 166 water utilities listed in this zone, of which 31 are privately owned, 37 publicly owned and 98 mutuals.

Zone 9: The zone leader is Claude H. Weekes, Supt., Fresno City Water Dept., with headquarters at Fresno. The zone includes the following counties: Fresno, Madera, Mariposa, Merced and Tuolumne. The total population of the five counties is 265,400. Of the 58 water utilities listed in the zone, 22 are privately owned, 17 publicly owned and 19 mutuals.

Zone 10: The zone leader is F. J. Rossi, City Engr., Dept. of Public Works, with headquarters at Modesto. The zone includes the following counties: Alpine, Amador, Calaveras, El Dorado, San Joaquin and Stanislaus. The total population of the six counties is 239,800. There are 50 water utilities listed in this zone, of which 29 are privately owned, 10 publicly owned and 11 mutuals.

Zone 11: The zone leader is Carl M. Hoskinson, Chief Engr., Division of Water, City of Sacramento, with headquarters at Sacramento. The zone includes the following counties: Butte, Colusa, Glenn, Nevada, Placer, Plumas, Sacramento, Sierra, Sutter, Yolo and Yuba. The total population of the 11 counties is 360,100. There are 85 water utilities listed in this zone, of which 46 are privately owned, 20 publicly owned and 19 mutuals.

Zone 12: The zone leader is O. G. Steele, Mgr., Siskiyou Div., California-Oregon Power Co., with headquarters at Yreka. The zone includes the following counties: Lassen, Modoc, Shasta, Siskiyou, Tehama and Trinity. The total population of the six counties is 98,900. There are 41 water utilities listed in this zone, of which 23 are privately owned, 11 publicly owned and 7 mutuals. In addition, this zone includes several large sawmill settlements provided with independent water supply systems.

Summary: The 12 zones contain the 58 counties of the state and vary in the number of counties included from 1 to 11. Their combined population, according to the 1940 census, is 6,907,400. The total number of water utilities listed is 1,549, of which 420 are privately owned, 264 publicly owned and 865 mutuals.

Instructions to Zone Leaders

Because of the impossibility of conducting a training school or some similar expedient for the zone leaders and the consequent lack of understanding in some quarters concerning functions and duties, a set of instructions was prepared and sent to all zone leaders and other interested persons. It was fully realized that the conditions in the several zones are not necessarily uniform and that no single set of instructions can apply equally or wholly to all leaders. However, the instructions were believed to be fairly comprehensive, although not necessarily complete as to detail or entirely applicable to all cases.

The zone leaders were requested to study these instructions carefully in conjunction with OCD Sanitary Engineering Bulletin No. 1, previously mentioned, a copy of which was furnished to each of them. They were warned to use these instructions with some discretion, applying them insofar as possible to the particular conditions governing their situations. It was stated to be important that the results which these instructions attempt to define and produce shall be obtained as completely as possible in each zone.

Their attention was invited to Public Proclamation No. 10, Headquarters, Western Defense Command, Fourth Army, U.S.A., Section 2, Sub. B-2, Restricted Lighting (Dimout) Regulations, referring particularly to industrial and protective lighting. It was urged that all water works officials in each zone become familiar with these provisions.

The text of the instructions distributed was as follows:

"The Zone Water Works Leader is charged with the responsibility of organizing his zone and developing the mutual aid plan. To this end he may desire to treat his zone as a single unit or, in the case of extensive zone areas, he may wish to establish sub-zones or districts which are more or less self-contained and self-sufficient and of such extent that mutual aid is possible and convenient. Normally, the county would be the ultimate or smallest unit.

"The functions of the zone leaders are threefold:

1. To supervise the accumulation of necessary information and data
2. To supervise and assist in the formulation of plans for carrying into effect, within the zone, the mutual aid program in times of emergency
3. To assist in the formulation of plans for the individual water systems or works, so that a maximum measure of community effort will be applied to the maintenance of the public water supplies.

"The duties and responsibilities of the Zone Water Works Leader are:

1. Maintain contact with county defense councils in his zone and coordinate the water supply program with other defense undertakings, making sure that water works superintendents or other responsible water works officials are duly represented on county defense councils
2. Assist local water works officials in preparing emergency plans for cooperation with fire departments (private, city, county, state and federal), health departments and local defense councils, making sure that here, also, the local water works superintendent or other active responsible official is given a proper voice in the general planning program
3. Foster co-operation among local water works personnel within the zone as a whole and within the counties therein as ultimate units

4. Assist communities and local water works officials in obtaining materials and funds to execute plans necessary to give effective service during emergency periods

5. Keep the Subcommittee on Water Supply of the State Council of Defense continually informed as to the status of operations in his zone through the Executive Secretary, Murray R. MacKall, State Railroad Commission, State Building, Civic Center, San Francisco

6. Keep the local water works superintendents and other officials informed with respect to all data, information and announcements released to him from the office of the Executive Secretary or from other official sources

7. Organize committees or designate persons to conduct such special surveys and studies as may appear to be desirable or necessary, and report such findings to the water works personnel in his zone and to the Subcommittee on Water Supply of the State Council of Defense, through its Executive Secretary

8. Sponsor meetings of water works personnel, or of water works personnel together with other defense personnel, by zones, counties or smaller districts, supplying the necessary leadership to carry out the program, with the assistance, on request, of the Subcommittee on Water Supply, the State Department of Public Health and other public agencies.

"In addition to the duties and responsibilities outlined above, the Zone Water Works Leader shall undertake to check the activities of the local water works departments with respect to the following:

1. Water system maps showing equipment essential to proper and effective control during periods of emergency

2. Periodic inspection and testing of valves, hydrants, pumps, chlorinators and other essential control equipment

3. Locking or proper fastening of covers of valve boxes, important sewer manholes, etc.

4. Installation of inter-connections between adjacent water works systems, wherever and whenever such interconnections are indicated as necessary or desirable to maintain service during emergencies

5. Inspection to determine the existence of cross-connections and the elimination of all which may be actually or potentially dangerous; or else the insurance of safety by means of positive disinfection whenever employed or active, together with use of double check valves

6. Collaboration with other utilities such as gas, electric, sewerage, etc.

7. Collaboration with other public services such as fire departments, police departments, health departments, other interested groups, etc.

8. Auxiliary or emergency drinking water supplies by the use of tanks, bottled waters or other suitable sources and measures

9. Regular and emergency chlorination in respect to equipment and supplies

10. Guarding of vulnerable features of the water works system

11. Standby service equipment available for emergency use

12. Laboratory control of water quality during normal and emergency conditions

13. Organization plans for emergency assembly

14. Raid notification to superintendent and crews, and how to be accomplished

15. Training of crews for emergency work

16. Arrangements for employee identification

17. Incident drills, practices and rehearsals

18. Registering plumbers and mechanics for emergency service

19. Preventing the diversion of water works employees to other defense duties."

Farm Water Supplies

In California farm water supplies will assume major significance in the event of an emergency, which may be expressed in terms of incendiary fires in rural areas, and of evacuation, if it should become expedient to disperse the refugees in such areas.

A truly stupendous work of organization, survey of conditions and facilities and assembly of information and data, as well as of the dissemination of information has been accomplished by the Agricultural Extension Service, University of California, under the direction of Warren R. Schoonover and J. B. Brown. To date 42 of the 58 counties of California have been surveyed and organized. The actual field survey work has been done or supervised by County Farm Advisors, assisted by such local personnel as the leaders of Farm Fire Companies, Forest Rangers, County Fire Wardens and other representatives of county defense agencies. In 35 of the counties, maps have been completed showing the location of available water supply sources and other appurtenant data. Each county has been subdivided into relatively small areas, each in charge of a competent, reliable warden, who has become informed with respect to the details of the comparatively small number of emergency supplies in his district and who will be prepared to act in case of emergency. The county maps have been designed to be cut up into district areas for the use of the respective wardens. In the 42 surveyed counties, 10,506 water points have been mapped and all important information concerning each has been obtained. Some 831 meetings of local groups have been held, at which the total attendance has been more than 21,600 persons.

Much attention has been given to the disinfection of water sources. In the meetings conducted on this project, emergency methods of water disinfection have been demonstrated both by Farm Advisors and by County Home Demonstration Agents. It has been found that the farm womenfolk have shown considerable interest in this matter and it is believed that the results will be salutary, quite aside from their emergency aspect. To date, more than 36,000 pamphlets dealing with emergency disinfection of rural water supplies have been distributed.

Future Work of Committee

Should widespread sabotage or enemy action occur, it is probable that the committee would be faced with certain new problems which have not as yet been visualized. In the main, however, it is believed that the future work of the committee will proceed along the general lines already laid down. It is anticipated that the committee must and will continue in service until the emergency is past, and afterward if work remains to be done. The surveys now under way will be completed as promptly as circumstances will permit. In respect to its other activities, it will attempt to perfect its operations and to render all possible assistance to the zone leaders and to the individual water supply systems of the state.

Wartime Activities of the Bureau of Sanitary Engineering of the Florida State Board of Health

By J. B. Miller

SINCE November 1941, the Bureau of Sanitary Engineering of the Florida State Board of Health has lost approximately 70 per cent of its engineering personnel to the armed forces. With this sharp decrease in personnel and the practical impossibility of finding additional qualified men, it became necessary to formulate a priority list of activities. "Water" heads that list for the obvious reason that it can be the greatest carrier of communicable diseases and thereby can affect the largest population. For convenience of action, the field has also been subdivided into: (1) water supplies in military and defense areas; and (2) water supplies in other areas.

In discussing the first of these divisions, it should be pointed out that, since the passage of the Selective Service Act in October 1940, a large number of military and naval bases have been located in Florida. In various cases these bases are being served by public water supplies, but even in cases where this is not true, the service personnel in the areas are consumers of public supply when they are in town during their off hours. For this reason, the operational branch of the Fourth Service Command has shown increasing interest in municipal water supplies surrounding military areas. On occasion, the military authorities have moved a portable bacteriological trailer laboratory into the towns to make regular checks on the bacterial quality of these supplies.

Other matters, such as cross-connections, chlorination and potability, on which corrective action has been necessary, have been called to the attention of the Bureau by the Liaison Officer of the U.S. Public Health Service in Atlanta, Ga. To date, the co-ordination of all parties concerned has been excellent, and all matters reviewed have been brought to a satisfactory conclusion. The greatest discussion has evolved around two factors—chlorination and bacterial standards. The final criteria developed are: (1) to carry chlorine residuals throughout the distribution system as far as possible, not to exceed 0.2 ppm. at terminal points of consumption; (2) to meet U.S. Public Health Service standards.

To make available accurate records for occasional transmission to the Army and to aid in the protection of municipal supplies, certain action either has been taken, or is in the process of being taken, by the Bureau. This

A paper presented on November 13, 1942, at the Florida Section Meeting, Miami, Fla., by J. B. Miller, Acting Director, Bureau of San. Eng., State Board of Health, Jacksonville, Fla.

action was initiated by communications to water suppliers, to the following effect:

Standard Practice for the Submission of Water Samples for Bacterial Analysis

We wish to standardize the method of collecting water samples which are sent by you to the State Board of Health for bacterial analysis. In the future, the following procedure should be followed:

1. Plants effecting any treatment (including aeration) submit:

(*a*) One sample from source
(*b*) One sample from plant effluent
(*c*) One sample from distribution system.

2. Plants pumping from wells directly into distribution systems submit:

(*a*) One sample from well.
(*b*) Two samples from distribution system.

Wells: Each water plant should number its wells consecutively, i.e., 1, 2, 3, etc., and a record of this designation should be kept by the plant. If only one well is used, or if all wells are led into a manifold, the sample should be marked either "Well No. 1" or "Manifold Wells, 2, 3, 5." If a number of wells, e.g., three, are used consecutively, samples from each well should be submitted separately on consecutive submission periods. This means, that, if you are on a monthly schedule, a sample from well No. 1 should be submitted in October, from well No. 2 in November, and from well No. 3 in December, etc.

Distribution System: Four strategic points along the distribution system should be chosen for sampling. At least two of these should be near a terminus. These points should be marked 1, 2, 3 and 4, respectively, and a record of this designation should be kept by the plant. As noted in section 2(b), above, two sampling points (one near the terminus) should be sampled in consecutive submission periods, i.e., samples submitted from points 1 and 3 in October, from 2 and 4 in November, from 1 and 3 in December, etc. As noted in section 1(c), samples from a terminus should be submitted alternatively.

Reporting of Chlorine Residual: In sampling from the plant effluent or the distribution system, a chlorine residual should be taken at the time of sampling and the result reported on the instruction sheet accompanying the sample bottle.

Monthly Report of Water Purification and Filtration Plants

The Bureau has developed a comprehensive form to be used for monthly reporting of operation data on filtration plants. This form is mailed out in duplicate upon request, if the plant giving the information desires to make it a part of regular plant records. For plants in which the personnel cannot during the emergency be burdened with the additional work of providing complete data, a simpler form, designed originally for reports by pumping plants using chlorination and/or ammoniation, has been made available and acceptable.

That the information required on these forms has no direct bearing on public health has been suggested. It is the feeling of the Bureau, however, that this information is particularly valuable to the plant operator, and, for this reason, it is willing to review the reports and to make suggestions for improvement as they are indicated.

With its limited staff, the Bureau has been confining its present activities almost entirely to plants in defense and military areas, but it stands ready to extend the program to any other plants interested.

Other Water Works Activities

Main Sterilization: Other work is being done by the Bureau in the water works field. In the last month, four naval bases have called for engineers from the Bureau to supervise the sterilization of water mains. The procedure followed in these cases has been as follows:

1. A chlorine dosage of 100 ppm. is applied and allowed to set for 24 hr.
2. The pipe is then flushed with treated water until the chlorine residual at the flush tap is equal to or slightly below that existing at the inlet to the new section.
3. Samples are collected from both the flush tap and inlet and, if feasible, from intermediate points.
4. The new section is not connected into the distribution system until the bacterial results are reported negative.
5. If the bacterial results indicate the presence of coliform organisms, the procedure is repeated in its entirety.

Mutual Aid Inventories: The Bureau is attempting to act as the control point for distributing and compiling inventories of excess and surplus water works material stocks. With the knowledge gained in the Mutual Aid Plan, only cities over 5,000 population have been contacted. If enough respond, the remainder of the cities will be contacted, and a master list compiled so that the Bureau can act as a clearing house.

Training Emergency Crews: All possible aid by the Bureau is extended to the E.S.M.W.T. program for the training of emergency crews to be used in the event of bombing or sabotage (*see* p. 199 of this JOURNAL). It is hoped, however, that the local water officials will be able to carry the greater part of the program by themselves.

With the added responsibility of water works in wartime, all efforts must be continued to assure the delivery of a safe, potable water. For this purpose, it is recommended that chlorine residuals be maintained throughout distribution systems as far as is practical and that water samples be submitted regularly for bacterial analysis.

Training of Water Works Personnel Under the E.S.M.W.T. Program

By N. C. Ebaugh

AN INCREASING number of water plant operators and chemists are being called into the armed services and the call of more lucrative positions in war industries has taken away a large number of water plant personnel. These two factors make it imperative that water works executives give increasing attention to the problem of training new employees for maintaining these important services.

More than a year before Pearl Harbor the engineering colleges in the country were authorized to start training technical personnel for vital war industries to supplement the normal flow of graduates from these colleges. Over half a million men and women have thus been given technical skills and made available to the war industries. These people have been trained in engineering drafting, fundamentals of radio, elementary sanitary engineering, pre-radar and ultra-high frequency, mold loft, chemistry, physics, mathematics, safety engineering, marine design and a wide range of other subjects numbering several thousand courses.

A paper presented on November 10, 1942, at the Florida Section Meeting, Miami, Fla., by N. C. Ebaugh, Institutional Repr., E.S.M.W.T. Program, Univ. of Florida, Gainesville, Fla.

Almost four thousand have been trained on the college level in Florida alone. This training program is handled through the U.S. Office of Education and is financed by appropriations of Congress. The University of Florida, chiefly through its College of Engineering, is in charge of the Engineering, Science and Management War Training (E.S.M.W.T.) program in this state. At the present time about a thousand trainees, of whom approximately three hundred are women, are enrolled under the program. Offices are established from Miami to Pensacola at nine points throughout the state.

Application to Water Works Personnel

It will be noted from this outline and summary that the program is designed to fill definite war needs, that it is on the college level, i.e., trainees must be high school graduates or equivalent, and that all instruction is presented without cost to the trainee.

The operation of water works certainly constitutes a vital and necessary business relative to the war effort. Many plants are furnishing water to Army, Navy and Marine establishments as well as to war industries. The quality of this water from a health standpoint must be assured through

continuous and competent supervision. The quantity of water maintained must be sufficient for fire protection, sanitary purposes, and industrial uses. Water works superintendents have a real responsibility to see that this work is carried on without interruption.

In general, new employees will have to be selected from the older group of men and from those who, for one reason or another, are not subject to draft under selective service.

Approximately 30 per cent of all trainees in Florida at the present time are women. Many industries are using women employees in technical capacities in increasingly large numbers. It would seem very satisfactory to train women for the positions of chemists, even if they cannot be used for positions requiring heavy manual labor.

If a definite need for training of water plant personnel exists and if a request will be addressed to the state E.S.M.W.T. Office, it is reasonably certain that the necessary arrangements for teaching the proper courses can be worked out.

Briefly these arrangements involve the enrollment of as many as 20 or 25 trainees in any one subject at any one point and these people must be high school graduates with training in mathematics and science. After a course has been prepared and when suitable instructors have been selected, a proposal is sent to Washington for approval. These details are mentioned to bring out the fact that it takes time to train people. Water works superintendents should try to look ahead at least three to six months in anticipation of personnel needs at that time.

Mutual Aid in New York During 1942

By Earl Devendorf

THE record of progress of the Mutual Aid Plan in New York State during 1942 is impressive and demonstrates what can be done when sound planning is combined with organization and teamwork. The great success which has attended the operation of the plan has been due in considerable measure to the fact that, in formulating the plan, the best minds that could be brought together to draft the plan incorporated in it a number of very specific objectives. Thus, from the beginning, local water officials have had some definite targets to shoot at, having at no time been placed in the position of wanting to make the best possible contribution to the war effort without knowing just how to go about it. In other words, through the specific objectives established for us in the plan, we all have had a reasonably clear idea of just what was wanted and we have proceeded in the direction of accomplishing these objectives with the knowledge that the closer we approach them, the better prepared we shall be to cope with any emergency.

Briefly let us consider some of these specific objectives, the distance already traveled toward them and some of the things which we should do during 1943 in regard to them:

1. One of the early objectives, conceived at a time when the materials and labor situation was not so critical as it is today, was promotion, to the greatest degree possible, of inter-connections, wherever feasible and practical, between adjoining public water supply systems, so that, in event of the failure of water supply in one system, service could be continued in some measure by drawing upon the other. Considerable progress was made in this regard, particularly in areas such as Nassau and Westchester Counties and in other regions where communities adjoin each other. Throughout the state there are now in existence 221 such inter-system connections, ready for operation in event of need. Most of these have been installed as a direct result of the Mutual Aid Plan. We are fortunate to have secured the installation of this number. Many water systems have thereby been considerably strengthened. There are perhaps another hundred locations throughout the state where such connections are desirable and should be installed, but, at the moment, in many cases, the War

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Excerpts from a memorandum, dated December 30, 1942, to zone and assistant zone water co-ordinators and all local water officials of New York State, issued by Earl Devendorf, State Water Co-ordinator, Asst. Director, Div. of Sanitation, State Dept. of Health, Albany, N.Y.

Other reports on the New York State Mutual Aid Plan were published in the January and August 1942 issues of the JOURNAL (**34**: 189, 1179 (1942)).

Production Board's regulations will not permit the use or purchase of materials needed for the purpose.

In 1943, we urge local officials to keep this objective in mind and, in cases where such inter-system connections are feasible, to give serious consideration to their installation if this can be accomplished in compliance with the War Production Board's regulations. In time, the materials situation will ease, although the outlook for this in 1943 is not good. These connections are desirable under peacetime as as well as wartime conditions, however, so, even if you are unable to proceed now with their installation, the time will come when the necessary materials can be obtained and the work completed. This should be done whenever circumstances will permit. (Chapter 574, Laws of 1942, which provides the legal foundation for our Mutual Aid Plan, requires that plans for such connections be approved by the State Water Co-ordinator.)

2. Another objective, closely allied with the first and having the same purpose, was the promotion of connections between public water supplies and the safe *approved* water supplies of industries. These are not to be confused with cross-connections between public supplies and unsafe or unapproved water supplies of industries which are prohibited by the State Sanitary Code. In many cases, the water supplies of industries such as milk plants, etc., are safe, and, if their quality is under adequate supervision by local water authorities, their connection with the public supply is desirable. In the past there have been several occasions during droughts or flood emergencies when the use of such industrial water supplies tided a small community over an acute period of water shortage. In approximately forty instances such inter-system connections are being maintained.

During 1943 we urge further consideration of the installation of such connections, with emphasis on adequate control and supervision over them and on the fact that all such connections require prior approval by the State Department of Health. The present materials situation of course will operate in most instances to prohibit further installations until WPB regulations are modified.

3. From the start of our Mutual Aid Program, we have stressed the urgency, in each municipality, of preparing and maintaining up-to-date maps and other records of the distributing system and detailed records of the location of valves and other important elements on the system. These records should be in duplicate so that, if one set is lost, the detailed information will still be available. We have sought to promote this objective as widely as possible. The needs for accurate records, maps, etc., are obvious and apply in normal times as well as in wartime. There are approximately 1200 separate water distribution systems in the state, but, up to the present, only 424 municipalities have brought their records up to date, according to information reported through our zone co-ordinators.

In all cases where no maps are in existence or where valve location records are not maintained and in all cases where present information is inaccurate or inadequate, we urge that immediate steps be taken to provide proper records. Attention to this objective should be highlighted during 1943 until the job is done.

4. Concomitant with the necessity for accurate records is the necessity for frequent testing of valves and fire hy-

drants, to assure their proper working condition at all times. In many municipalities inadequate attention has been given to this important matter.

During 1943 we urge that each local water authority establish some kind of program to assure that this matter receives the attention it deserves.

5. Collaboration and close co-operation between water and fire officials at the local level have been stressed repeatedly as an important objective of our Mutual Aid Plan. In many places this has been accomplished, but the matter needs further emphasis. Advance co-operative planning by both the water and fire officials as to possible use of emergency water supplies which may be pumped into the water system is particularly important. Up to the present, our zone co-ordinators have reported that 399 municipalities have made plans in advance for possible use of emergency supplies.

Information on such matters as the characteristics of valves and fire hydrants, the need for adapters and weak spots in the distribution system should be freely interchanged between water and fire officials. Co-operative studies or surveys should be undertaken to ascertain the defects or weaknesses in distributing systems and plans made for their correction to the maximum degree possible. In 232 of our municipalities such surveys were made during 1942. Even if it is not possible to effect any physical improvements in the distribution system at the moment, it is important that the weak spots of the system be fully understood by both the local water and fire authorities.

During 1943 all water officials are urged to give this important matter additional consideration and to take steps to create, if it does not already exist, a close harmonious working arrangement between the water and fire departments.

6. Similarly there should be collaboration and close co-operation between electric power and other utility officials in regard to problems of mutual interest. Demanding particular study and consideration, where pumps, etc., are dependent solely on electric power, is the situation which will arise if there is a power failure. This is a matter which calls for advance planning, either for operation of auxiliary power sources, such as gasoline engines, or the possible use of some emergency source of water supply. The ability of the system to operate on storage is a factor also to be considered in this connection. According to reports made by our zone co-ordinators, only 42 municipalities have given more than casual consideration to this matter.

There is a need to give particular emphasis to this general problem during 1943 and to lay plans accordingly.

7. The Mutual Aid Plan stresses the importance of collaboration between industry officials, fire officials and water officials in regard to water or fire protection service furnished to war industries. The records for the year indicate that the water officials in most of our municipalities which have important war industries have given particular attention to this matter.

8. Adequate consideration of the problems related to possible water works sabotage and of reasonable measures to provide the best possible protection against subversive activities has been one of the important objectives. There has been much activity in regard to adoption of precautionary measures, but the necessity for maintaining secrecy makes it impossible to indicate the extent to which the municipalities have made preparations.

Any water official who heretofore has not given full consideration to this matter will do well to study the possibilities and adopt such measures as are reasonable, necessary and possible under the particular local circumstances. Conditions make it seem that 1943 may be the year for attempted sabotage on a considerable scale. We have no way of knowing what the possibilities are, but it is wise to remain on the alert and to do whatever we can to forestall such attempts.

9. The preparation by each water authority of inventories of water works personnel, equipment, materials and supplies and the filing of this information with the Zone Water Co-ordinator has, of course, been one of the key objectives of our Mutual Aid Plan. To date, 702 local water authorities have filed such inventories and this feature of the plan is ready to go into action at any time.

Most of these inventories, however, were prepared several months ago and may be somewhat inaccurate now. It was our intention that these inventories be revised about once each year and that zone co-ordinators be notified promptly at any time when an important or significant change occurs, so that their records could be adjusted accordingly.

These inventories are needed to facilitate the extension of assistance from one municipality to another in time of emergency.

Undoubtedly, during 1943, water officials will be called upon to submit revised inventories or to make corrections to the existing records in the possession of zone co-ordinators. The reason that such request has been delayed is the fact that an arrangement is under consideration by the War Production Board whereby the State Water Co-ordinator may be utilized to handle the matter of surplus inventories and to act as a clearing house between municipalities for disposal of water works materials defined as surplus under the WPB P-46 order. The thought is that, if such an arrangement is officially placed in effect, the matter of obtaining inventories of surplus materials, as defined and referred to in P-46, and that of obtaining complete inventories for Mutual Aid purposes could be handled at the same time.

During the year there has been clarification on the matter of how local civilian protection directors fit into the scheme of extending aid from one water department to another in time of emergency. Under the War Emergency Act each local director has full power and it is his duty to direct the transfer of personnel or extension of assistance from one community to another, when both communities are in the same county and under his jurisdiction. At each control center there is, or should be, some person appointed to handle requests for water service aid and to attend to such matters. In the event of the need for assistance by a water superintendent during an emergency, when the civilian protection organization is operating, the water superintendent of a village should put a message through his local report center to the county control center, requesting assistance and specifying what is needed.

If the situation is one requiring assistance from a community in one county to a community in a different county, the procedure will require that the local director of civilian protection make the request for assistance to the State Director of Civilian Protection, whereupon the State Water Co-ordi-

nator, with the assistance of the zone co-ordinators, will handle the details involved in dispatching the needed assistance.

10. Integration of all local water departments and local water officials as important cogs in the civilian protection machinery of the local communities has been emphasized from the beginning in our Mutual Aid Plan. We have passed out of the confusion which attended our efforts in this respect early in 1942 to a position where local directors of civilian protection and most water officials have a clear understanding of just how the local water organization fits into the picture of civilian protection at the local level. Much of the early confusion and lack of understanding with respect to this matter were due to the fact that the state, with respect to its plans for civilian protection, was passing through a transitional and developmental stage. It has taken some time to get the machinery provided by the 1942 War Emergency Act functioning in a proper way; but it can be said that our Mutual Aid Plan is now effectively geared to the civilian protection structure at both the state and local levels. The Mutual Aid Plan is definitely incorporated as a division under the State Director of Civilian Protection.

We feel that we shall in 1943 have many opportunities, through practice drills, etc., to demonstrate how effectively water departments can operate during either simulated or real emergencies. It is pleasant also to reflect upon the fact that, during 1942, in the general scheme of civilian protection, water officials have risen from the position of so-called "forgotten men," to one where the importance of their work is clearly recognized as paramount by civilian protection directors and by the general public. In the early stages of the development of civilian defense the importance of maintaining water service was given little consideration.

11. The organization and training of an adequate number of auxiliaries (foremen of repair crews, supervisors of emergency water delivery services, valve operators, auxiliary pumping and treatment plant operators, etc.) has been an important objective in the operation of our Mutual Aid Plan and one toward which we must all continually work until, throughout the state, we have an ample reservoir of trained volunteer workers available for service in any kind of a catastrophe. We are now, of course, in the midst of this program. Although much has been accomplished, much still remains to be done before we can look with full satisfaction upon the job. This phase of the program is outlined in detail in Water Series Bulletin No. 1.*

The five regional emergency water service training schools held during July 1942 and attended by about 600 water superintendents have produced results. The purpose of these schools was, of course: (1) to acquaint local water officials with the details of the training program; (2) to provide local water superintendents, upon whom are imposed the main burdens of training auxiliaries, with lesson and lecture material for their use as a guide in giving the necessary instruction to their auxiliaries; and (3) to provide instruction in teaching aids and techniques. The assistance given to us by the State Office of War Training Programs has

* Organization and Training of Water Main Emergency Repair Crews and Auxiliary Personnel Assigned to Emergency Water Service Duties. Jour. A.W.W.A., **34**: 803 (1942).

been particularly valuable and is continuing. Soon to be published by that office, in one volume, is a complete assembly of all lessons, lectures and other material employed in the Water Auxiliaries Training Courses.

To assist water superintendents as much as possible in this water auxiliary training program, zone and assistant zone co-ordinators, in co-operation with local water officials, have participated in the organization and development of local group schools at which instruction in certain lessons of the prescribed course is given to the auxiliaries from several municipalities. An effort has been made to organize these local schools largely on a county basis, but in several instances the water superintendents of cities and villages have developed their own schools.

Up to date about 30 such local schools have been held, providing instruction to about 1,500 auxiliaries from 123 municipalities. It is our hope that by April 1943 most of these local group schools will have been completed in other counties of the state. It is estimated that, by that time, about 4,000 volunteer water auxiliaries will have completed the prescribed course of instruction.

Upon completion of the group schools it is necessary for each water superintendent to give his own auxiliaries sufficient additional instruction and practice to assure that each is competent to perform the emergency tasks assigned to him. The training of auxiliaries should be a continuing process. Therefore, from time to time after completion of the course of instruction, drills and supplemental meetings should be held, new problems analyzed and discussed, etc. Each superintendent should make definite plans to carry on a program to sustain the interest and enthusiasm of his auxiliaries. This is of particular importance if the bogging down of interest is to be avoided; and it is of urgent importance that there be no bogging down of interest on the part of auxiliaries during 1943. There are many problems, assistance in the solution of which might be given by the auxiliaries over a period of months, which would be of value to the community and afford a means of sustaining the auxiliaries' interest. Fire flow tests carried on intermittently over a period of months until the entire system has been covered would be a good program to undertake; or auxiliaries might be utilized at intervals to assist in the preparation of adequate records of valve locations, etc.

From the above it can be seen that we still have many things to accomplish during 1943. That we did achieve outstanding progress during 1942 is plainly evident. This was possible only by reason of the wholehearted co-operation given by local water authorities and the zone and assistant zone co-ordinators. We look forward to a continuation of this progress and co-operation during 1943, notwithstanding that 1943 can be anticipated as a difficult year for water works men. The loss of men to military service or war industries will impose new problems and burdens upon local water officials. The critical materials situation is certain to get worse before it gets better. However, the Mutual Aid program offers the means of reducing these difficulties to a minimum. All suggestions for improvement of this program will be heartily welcomed by the State Water Co-ordinator.

New York Section
of the
American Water Works Association

presents

OPERATION OF A CONTROL CENTER

A Play in One Act

written and produced by

The Staff of the Division of Sanitation
New York State Department of Health

in collaboration with

Colonel Thomas M. Sherman
Executive Officer
State Office of Civilian Protection

Cast of Characters

Narrator	Col. Thomas M. Sherman
Plotting Officer	Mr. A. F. Allen
Message Clerk	Mrs. M. B. Lyon
Messenger	Mr. C. W. Weber
Controller	Mr. C. R. Cox
Chief of Medical Service	Mr. W. D. Tiedeman
Chief of Police	Mr. H. J. Kircher
Fire Chief	Dr. F. L. Schacht
Public Works Chief	Mr. C. S. Leete
Chief of Water Service	Mr. A. F. Dappert
Chief of Utilities	Mr. C. B. Cleveland
Incoming Voices From District Warning Center and Several Report and Control Centers	Miss Ann Quirk
Albany and Columbia County Directors of Civilian Protection and Several Air Raid Wardens	Mr. Meredith Thompson
State Director of Civilian Protection	Mr. R. S. Taggart
Assistant Zone Water Co-ordinator (A)	Mr. W. J. Erickson
Assistant Zone Water Co-ordinator (K)	Mr. H. F. Edinger
Zone Water Co-ordinator	Mr. J. H. Burwell
State Water Co-ordinator	Mr. Earl Devendorf
City Water Superintendent	Mr. A. V. Kelly
Control Center Guard	Mr. Harold Rock

PREMIERE

The Little Theatre off Capitol Park
Albany, New York

Friday, October 16, 1942, 2:00 P.M.

Stage Setting

The desks representing the Communications Officer and Records Clerk will have placards, but will remain vacant throughout the action. The space representing the Albany Water Department Office is screened off from the control room. The persons who are to be the INCOMING VOICES are all in back of the screen. The microphone is set so as to be accessible to either the INCOMING VOICES or the CITY WATER SUPERINTENDENT. The panel will be indicated by a blackboard, turned edgewise to the audience. There are telephones for the CITY WATER SUPERINTENDENT, for each chief around the table and for the MESSAGE CLERK.

Instructions for Message Clerk

Each time the telephone rings over the loud-speaker, indicating an outside call to the control room, the MESSAGE CLERK will answer and simulate writing the message in triplicate. After she repeats the message over the phone, she holds the three copies over her head, whence they are picked up by the MESSENGER and distributed. Upon receiving a message for phoning, she makes the call and, upon completion, hands the message to the MESSENGER who completes the distribution.

Instructions for Messenger, Plotting Officer and Chiefs

The MESSENGER will have three different routes to follow in distributing messages:

(1) After the yellow alert, and as the MESSENGER comes on the stage, he will pick up three copies of the written message from the MESSAGE CLERK, hand one to the Communications Officer, then give them to PLOTTING OFFICER who will read them and return them to the MESSENGER. The MESSENGER will then deliver one copy to the CONTROLLER and one copy to the Records Clerk. The same procedure will be followed when the blue, red and white warning messages are received.

The procedure in (1) will be followed when incidents or incoming messages are reported to the MESSAGE CLERK. The only difference will be that the PLOTTING OFFICER will hold them long enough to plot the information on the panel board (which he will simulate).

(2) While the CONTROLLER is reading a message, the CHIEFS around the table will simulate writing messages and then simulate telephoning to the field representatives. After the simulated telephone calls, the MESSENGER will pick up the messages and deliver one copy to the CONTROLLER, hand two copies to the PLOTTING OFFICER who will hold them long enough to simulate plotting on the panel; then the MESSENGER will deliver the two copies to the Records Clerk.

(3) When an outmessage is prepared for the Delmar report center, the procedure will be for the MESSENGER to pick up three copies from the CHIEF OF WATER SERVICE, hand one to the CONTROLLER and two copies to the MESSAGE CLERK, who will read the message over the phone and then hand them back to the MESSENGER who will then hand one to the Communications Officer and the other to the PLOTTING OFFICER who will simulate plotting, after which the MESSENGER will deliver the message to the Records Clerk. The same procedure will be followed whenever there is an outgoing message through the MESSAGE CLERK.

Operation of a Control Center

NARRATOR—I shall ask you to stretch your imagination and believe that we are in a combined city and county control center. This center is manned 24 hours each day, a telephonist or message clerk being on duty at all times. [MESSAGE CLERK *takes her place on stage.*] You will observe that she is at her station now.

We cannot, of course, hope to reconstruct for you a completely equipped control center for this demonstration, nor duplicate exactly the manner in which it is run. We shall introduce some features which are not yet incorporated in the center we are demonstrating.

The idea is to give you some understanding of how the control center will fit in with your Mutual Aid Plan when further experience permits the development of co-ordination to a higher degree than now prevails. Procedures are subject to constant improvement. Our demonstration, therefore, may represent a slight projection into the future.

We are showing you a long table at which those in charge of the various services in the control center will take their places at the time of air raid alerts. For purposes of simplification, we are showing only a portion of the services which would be represented at the control center. The chairs which will be occupied by the chiefs of these various services are labeled for your information.

The chiefs of the various services are supposed to face the blackboard which is intended to represent a panel board. In this demonstration, however, in order that we may get the voices of the various chiefs across to the audience, we shall have them sit at the table facing you and put the control panel to one side. But remember that the real position of the control panel is in front of the control table. Also, instead of using pins and so on, we shall have our plotting officer use chalk and expect you to believe that he is actually using the prescribed equipment. Although it isn't there, we shall expect you to see a large clock built into the panel board. There are yellow, blue, red and white signal lights over the panel board. These at the moment are out.

Also something that you do not see, but which we must ask you to imagine, is a large map of the city showing all streets and roads, the boundaries of air raid warden zones and sectors, all stations from which service units of the civilian protection force operate, such as police stations, fire stations and so on. Keep in mind that this is a combined city and county control center. The center must function in relation to emergencies either within the city or in communities throughout the county. Therefore, in addition to maps and other data relating to the city, we also have on the walls of the control room similar maps giving essential data in regard to each town and village in the county and each report center in these various outside municipalities. In all of these surrounding communities, we have report centers which very much resemble a control center but usually are a little more simplified, with a smaller number of personnel, depending on local conditions. These report centers similarly are manned 24

hours each day. In the progress of this demonstration I think we shall be able to give you some idea of the lines of communication between report centers and control centers.

For this demonstration we were not able to provide all the properties which we really need. Therefore, when you see the actors going through the motions of telephoning messages we shall ask you to believe that they are actually making the calls.

We want to make some distinction between incoming and outgoing calls. Therefore, we shall ask you to believe that when a message is broadcast over the loud-speaker it represents either an incoming call or a conversation taking place outside of the control center.

Over on the other side of our stage we have shown a table and chair separated from the control room by a screen. You are to imagine that this represents the Office of the Albany Water Department, which is actually several blocks away from the control center. Obviously for purposes of demonstration, we have had to place these together on our stage.

Air raid wardens are being trained to report incidents clearly and concisely upon special incident report forms. If the incident is in Albany, the message will be phoned directly to our control center by the air raid warden. If the incident is in one of the villages or towns of the county, the message will come to the control center through the report center of that municipality, only when the report center desires assistance or is reporting movement of apparatus, equipment and personnel.

You will hear the incoming messages over the loud-speaker and then the verification of these messages by the Message Clerk at her station. The messages will be delivered slowly because accuracy is more important than speed. The Message Clerk must have time to record the message upon the triplicate incoming message form.

You will see the Messenger take these incoming messages from the Message Clerk and deliver them, one copy going to the Communications Officer, two copies to the Plotting Officer, who holds them long enough (1) to assign the incident a number and (2) to plot the incident on the map. Thence, the face copy goes to the Controller and the other copy to the Records Clerk.

The Local Director of Civilian Protection is in general charge, but the operations proceed generally with the Controller in charge of all operations around the control table. To simplify the demonstration, we shall assume that the local director will enter the room after the yellow warning, but we shall make him invisible.

When the Controller receives the incoming message, he reads it slowly to the service chiefs around the control table. Each service chief puts down the essentials of the message and then prepares a written outgoing message if the incident is such as to require it. This message is also prepared in triplicate. As soon as the message is written, the service chiefs who are involved in any way with the incident, phone directly to their field units or representatives in the field and direct the action which is to be taken. When a service chief has phoned his message to the field, he hands three copies to the Messenger, who delivers the face copy to the Controller, and two copies to the Plotting Officer who plots the information on the panel board, after which the two carbon copies finally are handed to the Records Clerk.

The time of our action is 4:00 A.M., Friday, October 16, 1942. The Mes-

sage Clerk is serving her shift and the control room guard is on duty as the demonstration begins. The first voice you will hear is from the Albany District Warning Center.

Telephone rings over loud-speaker.

MESSAGE CLERK—[*Picking up phone*] Albany 1234.

INCOMING VOICE—[*Over loud-speaker from District Warning Center*] Civil warning—Albany—Yellow.

MESSAGE CLERK—[*Repeating message*] Civil warning—Albany—Yellow.

INCOMING VOICE—O.K. What is your name?

MESSAGE CLERK—Mrs. Lyon.

NARRATOR—At this point, the message clerk hangs up and rings the internal warning system bell, pressing a button to turn on yellow warning light. Other control and report centers in the area involved have received similar yellow warnings and will take action similar to that which is to follow.

MESSAGE CLERK—[*Picking up phone*] 9-002.

ALBANY COUNTY DIRECTOR—[*Over loud-speaker, after slight pause*] Hello—Greenleaf's residence.

MESSAGE CLERK—Civil warning—yellow—time 4:00 A.M. [*Then making another call*] 9-7246.

CONTROLLER—[*Over loud-speaker, after slight pause, wearily, with yawn*] Hello.

MESSAGE CLERK—Civil warning—yellow [*hangs up receiver*].

NARRATOR—The message clerk has just passed on the warnings to the Local Director of Civilian Protection and to the Controller. She will make some additional calls to the chiefs of all, or perhaps only some, of the various services, telephone and message clerks, etc., depending upon the local arrangements which have been made for the Local Warning Yellow, Blue and Red Sequence Lists. Perhaps some of those who are to man the control table or staff the control center will receive their notification from the Commander or the Controller. The procedures in this respect will vary somewhat between control and report centers. In any event the chain of calls to get the yellow alert warnings to all persons who should be notified or who are to report to the control center should require not more than seven minutes. We shall assume now that all of the calls have been completed and that all those who are to report to the control center are on their way except the Chief of Water Service who has lingered in his home long enough to get the warning passed on to the City Water Superintendent. The telephone conversation you will hear over the loud-speaker takes place entirely outside of the control center.

CHIEF OF WATER SERVICE—[*Over loud-speaker*] Hello, Kelly, is that you?

CITY WATER SUPERINTENDENT—[*Over loud-speaker*] Yeah, this is Kelly. Is this you, Cassidy?

CHIEF OF WATER SERVICE—Yeah, this is Cassidy. I got a nice present for you, Kelly.

CITY WATER SUPERINTENDENT—What do you mean—a nice present—at this hour of the morning?

CHIEF OF WATER SERVICE—Yellow alert at 4:05. We've got about 30 minutes I think. Get your men alerted and when you get to the office, put a message through to me at the Control Center. So long, Kelly.

CITY WATER SUPERINTENDENT—So long, Cassidy [*slight pause*] Damnation!

At this point, and after a little pause to indicate lapse of time, the various chiefs of services and other members of the control staff begin to make their

appearance on the stage, one by one, and take their places at the control table, except the CHIEF OF WATER SERVICE *who is a little late.*

NARRATOR—We shall assume that several minutes have elapsed since the yellow warning was received and that the control staff is assembling with the exception of the Chief of Water Service who appears to be a little late [*pause while chiefs of services take their places*].

CONTROLLER—[*After chiefs have taken their places at table*] Where in the hell is Cassidy?

CHIEF OF MEDICAL SERVICE—If you ask me, I think at this hour of the morning he's probably gone back to bed.

CHIEF OF POLICE—Shall I send out for him?

CONTROLLER—No, I guess not. Probably nothing doing anyway and he may come in pretty soon.

CHIEF OF PUBLIC WORKS—Kinda tough at that to have to roll out this early.

MESSAGE CLERK—[*Joining in general conversation*] Maybe it's the real McCoy.

CHIEF OF UTILITIES—Well, if it is, it will help break the monotony.

CITY WATER SUPERINTENDENT *takes place in Albany Water Office and simulates telephoning. After good pause telephone rings over loud-speaker.*

MESSAGE CLERK—County Control.

CITY WATER SUPERINTENDENT—[*Over loud-speaker*] Message to Cassidy—Kelly at office and all foremen alerted.

MESSAGE CLERK—[*Repeating and simulating writing of message*] Message to Cassidy—Kelly at office and all foremen alerted [*hangs up receiver*].

MESSENGER *takes written copies to Communications Officer,* PLOTTING OFFICER, *who just glances at it, then to Report Clerk and to* CONTROLLER. *A little later, the* CHIEF OF WATER SERVICE *walks in.*

CONTROLLER—Well, here comes Cassidy.

POLICE CHIEF—Wide awake as usual.

WATER CHIEF—I was delayed a little—couldn't find my car keys.

CONTROLLER—Message for you, Cassidy—Kelly apparently hit the deck before you did [*hands message to* CHIEF OF WATER SERVICE].

More ad lib *around control table—good pause—then telephone rings over loud-speaker.*

MESSAGE CLERK—[*Picking up receiver and answering*] County Control.

INCOMING VOICE—[*Over loud-speaker—from District Warning Center*] Civil Warning—Albany—blue.

MESSAGE CLERK—Civil warning—Albany—blue.

At this point MESSAGE CLERK *pushes button to change the yellow signal to blue and hands three copies of written message to* MESSENGER *for distribution to Communications Officer, Plotting Officer, Report Clerk and* CONTROLLER.

NARRATOR—In some cases some of the chiefs of services do not report to the control center until after the blue signal is received, in which case the procedure for notification is the same as we illustrated when the yellow warning was received. However, for the sake of simplicity we shall assume that just prior to receipt of the blue signal the control center was fully staffed. The red signal, if it comes, usually follows the blue by about five minutes.

Good pause—then telephone rings over loud-speaker.

MESSAGE CLERK—[*Answering telephone*] Albany 1234.

INCOMING VOICE: [*Over loud-speaker—from District Warning Center*] Civil warning—Albany—red.

MESSAGE CLERK—Civil warning—Albany—red [*she again pushes the button to change the signal from blue to red.*]

NARRATOR—At this point, of course, the red signal has been flashed also to the public warning stations and the blackout is on. Air raid wardens and other civilian protection forces are at their stations ready to report incidents or receive instructions. Incidents may be reported in a very few minutes.

Good long pause—then telephone rings over loud-speaker.

MESSAGE CLERK—[*Answering telephone*] County Control.

AIR RAID WARDEN—[*Over loud-speaker—slowly and distinctly*] Air raid damage . . . Warden B-2 reporting . . . Second Avenue and South Pearl Street. Incendiary bombs only. No casualties. . . . One fire at 3 Second Avenue . . . may get out of control. Small crowd collecting. Time 4:36 A.M. That is all.

MESSAGE CLERK—[*Repeating message rapidly as she has recorded it*] Air raid damage . . . Warden B-2 reporting . . . Second Avenue and South Pearl Street. Incendiary bombs only. No casualties. One fire at 3 Second Avenue . . . may get out of control. Small crowd collecting. Time 4:36 A.M.

AIR RAID WARDEN—Correct.

MESSAGE CLERK *hangs up.*

NARRATOR—The Message Clerk always repeats the message back to the warden to insure accuracy and records the actual time of receipt in message room. She then hands the written message in triplicate to the messenger, who delivers one copy to the Communications Officer and, thence, two copies to the Plotting Officer, who holds them long enough to assign the incident number and to plot the data on the panel board and, thence, the original copy to the Controller and a carbon copy to the Records Clerk.

CONTROLLER—[*Rising and reading message slowly*] Air raid damage . . . Second Avenue and South Pearl Street. Incendiary bombs only. No casualties. One fire at 3 Second Avenue. May get out of control. Small crowd collecting. Time 4:36 A.M.

POLICE *and* FIRE CHIEFS *write out messages while* CONTROLLER *is speaking. After slight pause, they simulate telephoning.*

CONTROLLER—[*After* FIRE *and* POLICE CHIEFS *have completed simulated calls*]—Police, what do you report?

POLICE—Prowl car No. 6 has been dispatched.

CONTROLLER—Fire?

FIRE—Engine Company No. 3 has been dispatched.

CONTROLLER—Medical?

MEDICAL—No service required. However, am notifying Health Commissioner to issue boil water warning immediately and get broadcasts over radio as soon as possible after the sounding of the "All Clear."

CONTROLLER—No other services seem to be required. Is that correct? [*Nods of assent, etc.*]

MESSENGER *then gathers messages from* POLICE *and* FIRE CHIEFS, *hands face copies to* CONTROLLER *and two copies to* PLOTTING OFFICER, *who plots the services dispatched, and thence passes on the two copies to the Records Clerk.*

NARRATOR—You will observe that in this instance no copies of the message were delivered either to the Message Clerk or Communications Officer.

The copies went direct to the Controller and Plotting Officer and thence to the Records Clerk. Only if outgoing messages are phoned to the field by the Message Clerk is the route through the Message Clerk and Communications Officer followed. All of the chiefs around the table have direct lines of communication to their representatives in the field. You will observe that while I have been talking the Plotting Officer has plotted the services dispatched on the plotting board.

After a good pause, telephone rings over loud-speaker.

MESSAGE CLERK—[*Answering telephone*] County Control.

AIR RAID WARDEN—[*Over loud-speaker—slowly and distinctly*] Serious air raid damage. Warden A-76 reporting. State and Broadway. Demolition bomb. 50-foot crater . . . broken water, gas and sewer lines. . . . Incendiary bombs also. Old Post Office Building on fire. Apparently no casualties. Streets blocked. No services on spot. Time 4:55 A.M. That is all.

MESSAGE CLERK—[*Repeating message rapidly, and letting her voice fade out*] Serious air raid damage. Warden A-76 reporting. State and Broadway. Demolition. . . .

NARRATOR—The Message Clerk repeats the message as usual, then hands three copies of the recorded message to the Messenger who distributes them as usual, one to Communications Officer, two to the Plotting Officer, who holds them long enough to assign the incident number and to plot the data, and then one copy to the Controller and the other to the Records Clerk.

CONTROLLER—[*Upon receiving written message, slowly*] Serious air raid damage. State and Broadway. Demolition bomb. 50-foot crater . . . broken water, gas and sewer lines. Incendiary bombs also. Old Post Office Building on fire. Apparently no casualties. Streets blocked. No services on spot. Time 4:55 A.M.

While the message was being read, the chiefs of the various services have been jotting down the message and immediately write their outmessages and simulate telephoning to the field.

CONTROLLER—[*After chiefs have completed simulated calls*] Police, what do you report?

POLICE—Squad cars 8 and 16 dispatched.

CONTROLLER—Fire?

FIRE—Have ordered dispatch of Engine Companies Nos. 6 and 7 to scene.

CONTROLLER—Medical?

MEDICAL—No service needed apparently. Am standing by.

CONTROLLER—Public Works?

PUBLIC WORKS—Repair Crews Nos. 1 and 2 have been sent.

CONTROLLER—Water?

WATER—Have ordered repair crews 10 and 13 and valve crews 6 and 7 to incident.

CONTROLLER—Utilities?

UTILITIES—Order given for gas main repair crew No. 2 equipped with respirators to proceed at once.

MESSENGER *picks up the various messages from the chiefs of services and delivers them to the* CONTROLLER *and* PLOTTING OFFICER. *The* PLOTTING OFFICER *records the services dispatched, etc.*

NARRATOR—Among the messages issued from the control center to the field was a message from the Chief of Water Service to the City Water Superintendent in the Water Office. For the moment we will consider that we are in the Albany Water Office and

not the control center. The Superintendent is telephoning to the Quackenbush Station.

A good pause—then CITY WATER SUPERINTENDENT *simulates telephone call.*

CITY WATER SUPERINTENDENT—[*Voice over loud-speaker, with sufficient pauses to indicate more or less a normal telephone conversation*] Is that you, Joe? [*Pause*] Listen, there's been a hell of a bombing at State and Broadway. [*Pause*] There's a 50-foot crater with damage to water, sewers and gas. [*Pause*] Yeah, send repair crews 10 and 12 there at once. [*Pause*] And Joe, you'll need at least two pumps. [*Pause*] Get valve crews 6 and 7 on the job. Get the valves closed off and bypass, if you can. [*Pause*] Hell, Joe, the fire department needs the water. [*Pause*] Listen, Joe, that's a 24-inch main there. If there's only the one break, fire hydrants 13, 20 and 22 can be fed through the 20-inch on Green Street. [*Pause*] Yeah, on Green Street. The main thing, Joe, is to get the break valved off. We can wait 'til daylight to start repairs. [*Pause*] Got everything straight, Joe? [*Pause*] O.K., report back to me in ten minutes. [*Hangs up.*]

NARRATOR—We are now back in the control center again.

Good pause, then telephone rings over loud-speaker.

MESSAGE CLERK—[*Answering telephone*] County Control.

AIR RAID WARDEN—[*Over loud-speaker, slowly and distinctly*] Air raid damage. Warden C-17 reporting. Incendiary bomb. Pine and Western Avenues. Warden C-19 severely injured when bomb fell. Have given first aid. Send ambulance. That is all.

MESSAGE CLERK—[*Repeating message rapidly, with voice fadeout*] Air raid damage. Incendiary bomb. Pine and Western Avenues. Warden C-19 severely injured when. . . .

MESSENGER *picks up recorded message forms and distributes them as usual.*

CONTROLLER—[*When he receives message*] Air raid damage. Incendiary bomb. No fires. Pine and Western Avenues. Warden C-19 severely injured when bomb fell. Have given first aid treatment. Send ambulance.

While CONTROLLER *speaks,* MEDICAL CHIEF *takes down message and prepares outmessage. Then* MEDICAL *simulates phoning.*

CONTROLLER—[*After* MEDICAL *has completed call*] Police, what do you report?

POLICE—None required.

CONTROLLER—Fire?

FIRE—No service needed.

CONTROLLER—Medical?

MEDICAL—Ambulance 14 dispatched with orders to deliver patient to Memorial Hospital.

CONTROLLER—Public Works?

PUBLIC WORKS—No service needed.

CONTROLLER—Apparently no further services are needed. Is that correct? [*Nods of assent, etc.*]

MESSENGER *then picks up messages and delivers them as usual. Good pause, then telephone rings over loud-speaker.*

MESSAGE CLERK.—County Control.

AIR RAID WARDEN—[*Over loud-speaker, slowly*] Air raid damage. Warden F-7 reporting. Ajax Felt Mills. Incendiary bombs several points. One demolition bomb destroyed water and gas mains. Mill on fire. Casualties probable. Time 5:15 A.M.

MESSAGE CLERK—[*Repeating message*] Air raid damage. Ajax Felt Mills. Incendiary bombs. . . .

MESSENGER *picks up messages and delivers them to Communications Officer,* PLOTTING OFFICER *and* CONTROLLER.

CONTROLLER—[*After receiving message, slowly*] Air raid damage. Ajax Felt Mills. Incendiary bombs several points. One demolition bomb destroyed water and gas mains. Mill on fire. Casualties probable. Time 5:15 A.M.

Chiefs take down message, write out messages and simulate telephone calls.

CONTROLLER—[*After chiefs have simulated telephone calls*] Police, what do you report?

POLICE—Squad cars 11 and 12 dispatched.

CONTROLLER—Fire?

FIRE—Engines 2, 8 and 13 to mill.

CONTROLLER—Medical?

MEDICAL—Ambulance 5 on the way.

CONTROLLER—Public Works?

PUBLIC WORKS—Repair crew 21 ordered.

CONTROLLER—Water?

WATER—If the break is as reported, the fire department will be without water unless the old emergency pumping station is cut in. This takes water directly from the Hudson.* Have ordered out valve crew 16, water main repair crew 12 and pump and chlorinator crew No. 1. We'll valve off the break and pump heavily chlorinated water into the lines on the south side of the break. Fire hydrants on the north side ought to be able to supply water after the break is valved off.

CONTROLLER—Good. Utilities?

UTILITIES—Gas repair crew 6 notified.

MESSENGER *picks up messages and delivers one to* CONTROLLER *and two copies to* PLOTTING OFFICER.

NARRATOR—Again we shall move to the Albany Water Office and listen in to what has been going on.

CITY WATER SUPERINTENDENT—[*Over loud-speaker after slight pause*] Hello, Slattery, is that you? [*Pause—then slowly*] Listen, get valve crew 16 and repair crew 12 out to the Ajax Mills right away and send pump-chlorination crew No. 1 to the old emergency pumping station. [*Pause*] Yeah, demolition bomb, water and gas mains broken and the mill's on fire. [*Pause*] To supply fire hydrants and the mill sprinkler system we will have to cut in the old pumping station. [*Pause*] Yeah, this feeds into the system south of the break. I think the north side is O.K., but check this. And remember we are sending Hudson river water into the system. Make sure we're getting a good 50 parts per million residual chlorine. [*Pause*] Yeah—deep red color. [*Pause*] Get the break valved off. Several small fires in the neighborhood. Let the repairs go until daylight, Slattery. Everything clear? [*Pause*] O.K. Get a report back to me as soon as possible.

NARRATOR—Sometime in the course of the proceedings, the "All Clear" may be sounded, but the staff will hang around for perhaps several hours to clear up all incidents and handle requests for assistance which may come from outside report centers. In any case some of the staff including the PLOTTING OFFICER will stay on duty until all services dispatched are returned to their stations and until conditions have returned to normal.

A good pause—then telephone rings.

MESSAGE CLERK—Albany 1234.

INCOMING VOICE—[*Over loud-speaker, from District Warning Center*] Civil warning—Albany—white.

* See Editorial Note, p. 222.

MESSAGE CLERK—Civil warning—Albany—white [*white light turned on*].

NARRATOR—The next incident is intended to illustrate the procedure which is followed when local services are inadequate and when a local report center sends in a request for assistance to the county control center. This will involve the dispatching of assistance from one community to another within the same county. Remember the "All Clear" has been sounded—perhaps an hour ago—but the staff is still on duty.

Telephone rings over loud-speaker.

MESSAGE CLERK—County Control.

INCOMING VOICE—[*Over loud-speaker, slowly*] Bethlehem Report Center calling. Serious demolition bombing at four corners. Everything under control, but we need help in getting water service restored. We need 150 feet of 10-inch cast-iron bell and spigot, four 10-inch gate valves, four 10-inch sleeves, preferably split, although solid will do, two trench pumps and one repair crew. Have crew with materials report to Superintendent Hotaling who is on the job at the four corners, intersection of Delaware and Kenwood in Delmar. When may we expect help?

MESSAGE CLERK—I'll phone you in a moment, but let me check the message. Bethlehem Report Center calling. Serious demolition bombing at four corners. Everything under. . . .

MESSENGER *picks up message and distributes copies as usual.*

CONTROLLER—[*After he receives message*] Bethlehem Report Center calling. Serious demolition bombing at four corners. Everything under control, but we need help in getting water service restored. We need 150 feet of 10-inch cast-iron bell and spigot, four 10-inch gate valves, four 10-inch sleeves, preferably split, although solid will do, two trench pumps and one repair crew. Have crew with materials report to Superintendent Hotaling who is on the job at the four corners, intersection of Delaware and Kenwood, Delmar. When may we expect help?

While CONTROLLER *speaks,* CHIEF OF WATER SERVICE *takes notes and writes outgoing message.* MESSENGER *picks up copies, delivers them to* CONTROLLER.

CONTROLLER—Water, can you send assistance?

WATER CHIEF—Yes, but I can't send it from Albany. My crews are busy. My inventory of water works material for the county is not yet complete. I'll check with Assistant Zone Co-ordinator Erickson to see where we can get it. In the meantime that message should go out to Delmar to let them know that help will be sent.

CONTROLLER *sends message on to* MESSAGE CLERK. *He stands there while she telephones.*

MESSAGE CLERK—9-234.

INCOMING VOICE—[*Over loud-speaker*] Bethlehem Report Center.

MESSAGE CLERK—[*Slowly*] County Control speaking. Your request for assistance is being attended to. You may expect the help requested within an hour. Please acknowledge receipt when it arrives.

INCOMING VOICE—Thanks, Albany. Maybe we can do something for you some time.

WATER CHIEF—[*Picking up phone*] Get me 9-3351 [*telephone rings over loud-speaker*].

ASSISTANT ZONE WATER CO-ORDINATOR (A)—[*Over loud-speaker*] Erickson speaking.

WATER CHIEF—This is Cassidy at the Albany Control Center. Say, I wish you'd get me a copy of your in-

ventory for Albany County. Yeah—I need it now. Delmar needs one repair crew, 150 feet of 10-inch cast-iron bell and spigot, four 10-inch gate valves, four 10-inch split sleeves, although solid will do, and two trench pumps. I can't send it from Albany. Where can I get it?

ASSISTANT CO-ORDINATOR (A)—Wait 'til I check my books. [*Pause*] You can get all of it but the trench pumps from Cohoes. You can get the trench pumps from Watervliet.

WATER CHIEF—Thanks. [*Hangs up and writes out two messages.* MESSENGER *picks them up and delivers one copy to* CONTROLLER *and then one copy to* MESSAGE CLERK. *Waits until messages are telephoned, then hands them to Communications Officer to read and then delivers them to* PLOTTING OFFICER *and then to Records Clerk.*

MESSAGE CLERK—8-6001.

INCOMING VOICE—[*Over loud-speaker*] Cohoes Report Center.

MESSAGE CLERK—[*Slowly and distinctly*] Albany County Control. Take this message. You are directed to dispatch the following assistance to Superintendent Hotaling, intersection Delaware and Kenwood Avenues, Delmar, as soon as possible: one water works repair crew, 150 feet of 10-inch cast-iron bell and spigot, four 10-inch valves and four 10-inch split sleeves, although solids will do. Phone back when assistance has started. Check the message [*Pause—then hangs up*].

MESSAGE CLERK—8-7412.

INCOMING VOICE—[*Over loud-speaker*] Watervliet Report Center.

MESSAGE CLERK—[*Slowly and distinctly*] Albany County Control Center. Take this message. You are directed to dispatch the following assistance to Superintendent Hotaling, intersection of Delaware and Kenwood Avenues, Delmar, as soon as possible: two trench pumps. Phone back when assistance has started. Check the message. [*Pause—then hangs up*].

MESSENGER then delivers the written messages to *Communications Officer,* PLOTTING OFFICER *and Records Clerk.*

NARRATOR—The last incident we shall attempt to demonstrate will show how mutual water assistance is to be extended from the municipality of one county to the municipality of another in times of emergency and how the State Water Co-ordinator and his Zone and Assistant Zone Co-ordinators are to function in such situations.

The incident will occur in Hudson and Hudson will request assistance. The Columbia County Control Center, unable to get the required aid itself from any other place in the county, will ask for aid through the Office of the State Director of Civilian Protection. This assistance will be provided partly from the city of Albany, partly from Schenectady and partly from Catskill in Greene County. In this way, several counties and control centers will be involved. For the moment we are no longer in the Albany Control Center but in the Office of the State Director of Civilian Protection.

Telephone rings over loud-speaker.

INCOMING VOICE—[*Over loud-speaker*]—State Office of Civilian Protection. [*Pause*] Yes, I'll connect you with General Haskell.

STATE DIRECTOR OF CIVILIAN PROTECTION—[*Over loud-speaker*] This is General Haskell.

COLUMBIA COUNTY DIRECTOR—[*Over loud-speaker*] Hello, General. This is Mr. Jones, Civilian Protection Director of Columbia County. Damage in Hudson has been extensive. Superintendent Wardle needs two additional water main repair crews, 200

feet of 12-inch cast-iron pipe, three 12-inch valves, seven 12-inch split sleeves, a portable pump of 500 gpm. capacity against a 200-foot head with motive power, and seven cylinders of chlorine. I've scoured the county, but we can't get the stuff any place.

State Director of Civilian Protection—[*Over loud-speaker*] Just a moment, Mr. Jones. I'll have you repeat that request to Mr. Devendorf, the State Water Co-ordinator. He'll get help to you.

Narrator—We'll cut in only on Devendorf's conversation.

Pause.

State Water Co-ordinator—[*Over loud-speaker—slowly and with pauses to indicate normal telephone conversation*] This is Devendorf, what is it you need? [*Pause—then repeating slowly*] Two repair crews . . . 200 feet of 12-inch cast-iron pipe . . . three 12-inch valves . . . seven 12-inch split sleeves . . . one portable pump of 500 gpm. capacity against a 200-foot head with motor . . . and seven cylinders of chlorine. [*Pause*] You can tell Wardle that we'll have this on the way as soon as I can get it started. It may take half an hour or so. [*Pause*] You're welcome. Just let me know when you receive the assistance. [*Pause*] Goodbye!

Narrator—The State Water Co-ordinator continues his calls. He rings his Zone Water Co-ordinator.

The following conversation takes place over the loud-speaker.

State Co-ordinator—Schenectady 8-0062.

Zone Co-ordinator—[*After good pause*] Burwell speaking.

State Co-ordinator—Hello, John. This is Devendorf. Wardle at Hudson needs help. Got a pencil and paper? [*Pause, then slowly*] He wants two repair crews . . . 200 feet of 12-inch cast-iron pipe . . . three 12-inch valves . . . seven 12-inch split sleeves . . . one portable pump of 500 gpm. capacity against a 200-foot head with motor . . . and seven cylinders of chlorine. [*Pause*] Have you got all that down?

Zone Co-ordinator—[*Repeating*] Two repair crews, 200 feet of 12-inch cast-iron pipe, three 12-inch valves, seven 12-inch split sleeves, one portable pump of 500 gpm. capacity against a 200-foot head equipped with motor and seven cylinders of chlorine.

State Co-ordinator—That checks O.K. From my records, I figure that you can supply from Schenectady all but the seven cylinders of chlorine and the portable pump. I think we can get the chlorine from Albany. What do you suggest?

Zone Co-ordinator—Hang on a minute until I check my inventories. [*Good long pause*] Well, Devendorf, I can supply the two repair crews, 200 feet of 12-inch pipe and the valves, but I'm short on sleeves. Albany has plenty of sleeves so I'll get Cassidy to release them. Albany's O.K. for the chlorine too, but I've got no portable pump of the specifications requested. Do you want to order the transfers or shall I do it?

State Co-ordinator—No, you take care of it. We can handle it either way but I've got to arrange with Darrow in Kingston to get a pump and I'm pretty busy. To make everything official you place an order through the Schenectady Control Center to yourself to send the crews, pipe and valves to Hudson and put another order through the Schenectady Control Center to the Albany Control Center to get the sleeves and chlorine released from Cassidy. When you get the orders cleared, better tell Erickson and have

him go down to Hudson to see if Wardle needs any more help. Albany and Delmar are getting straightened anyway and Hudson was the only other place seriously damaged in the state. Everything clear?

ZONE CO-ORDINATOR—I've got everything straight. I'll report back to you when the crews and equipment are on the way. So long.

STATE CO-ORDINATOR—So long, John. [*Hangs up, then makes another call*] Get me Kingston 6-7342 [*Good long pause*].

INCOMING VOICE—Kingston Water Department.

STATE CO-ORDINATOR—Mr. Darrow, please—Devendorf calling.

VOICE—Mr. Darrow is out of town today. He'll be back this evening.

STATE CO-ORDINATOR—All right. Thank you. I'll talk with him later. Good-bye. [*Hangs up—then makes another call*] Get me Mr. Edinger at Kingston 3-5643.

ASSISTANT ZONE WATER CO-ORDINATOR (K)—[*Good long pause*] Edinger speaking.

STATE CO-ORDINATOR—This is Devendorf. I tried to call Darrow but he is out of town. Wardle at Hudson is in trouble and needs a portable pump of 500-gpm. capacity, equipped with a motor that will work against a 200-foot head. According to my records, Catskill has one. Will you check your records.

ASSISTANT CO-ORDINATOR (K)—Just a minute. [*Good pause*] That's right. It's mounted on a truck—gasoline-engine driven.

STATE CO-ORDINATOR—That's fine. Will you send an order through your Control Center to the Catskill Report Center to get it on its way?

ASSISTANT CO-ORDINATOR (K)—Sure, I'll have it started in a half-hour.

STATE CO-ORDINATOR—Better phone Superintendent Johnson at Catskill direct and then put the official order through on it.

ASSISTANT CO-ORDINATOR (K)—That's what I was planning to do.

STATE CO-ORDINATOR—And get hold of Darrow tonight and let him know what's happened; also let me know when the pump has started.

ASSISTANT CO-ORDINATOR (K)—O.K., Devy. I've got everything straight. So long.

Pause.

NARRATOR—We are coming back once again into the Albany County Control Center.

Good pause, then telephone rings over loud-speaker.

MESSAGE CLERK—Albany County Control Center.

INCOMING VOICE—[*Over loud-speaker, slowly*] This is Schenectady County Control Center. Take a message. To Director Greenleaf, Albany County. By order of the State Office of Civilian Protection, through State Water Co-ordinator Devendorf, you are directed to arrange for the dispatch of the following equipment from the Albany Water Department to Superintendent Wardle of the Hudson Water Department as soon as possible: seven 12-inch split sleeves and seven cylinders of chlorine. Notify me through Schenectady County Control Center when the assistance requested is started on its way. Signed, J. H. Burwell, Zone Water Co-ordinator.

MESSAGE CLERK—[*Repeating message*] To Director Greenleaf, Albany County. By order of the State Office of Civilian. . . .

Messages handed to MESSENGER, *who distributes them as usual.*

CONTROLLER—[*After he receives message*] To Director Greenleaf, Al-

bany County. By order of the State Office of Civilian Protection, through State Water Co-ordinator Devendorf, you are directed to arrange for the dispatch of the following equipment from the Albany Water Department to Superintendent Wardle of the Hudson Water Department as soon as possible: seven 12-inch split sleeves and seven cylinders of chlorine. Notify me through Schenectady County Control Center when the assistance requested is on its way. Signed, J. H. Burwell, Zone Water Co-ordinator.

WATER CHIEF *is telephoning—pause.*

WATER CHIEF—Hello, Kelly. How soon can you start a truck to Hudson?

CITY WATER SUPERINTENDENT—[*Over loud-speaker*] In about ten minutes.

WATER CHIEF—Supt. Wardle in Hudson needs some help. Load up seven 12-inch split sleeves and seven cylinders of chlorine and get started as soon as you can. Got everything straight?

CITY WATER SUPERINTENDENT—Seven 12-inch split sleeves and seven cylinders of chlorine to Wardle at Hudson. I'll move the truck and sleeves out of here in 10 minutes and stop at the filter plant on the way down to pick up the chlorine. Is that all?

WATER CHIEF—That's all, Kelly. So long.

CONTROLLER—Water, what have you to report?

WATER CHIEF—The help requested by Hudson and ordered by Zone Water Co-ordinator Burwell will leave Albany in 10 minutes.

CONTROLLER—Good, I guess we'd better notify Burwell. [*Writes out message.* MESSENGER *delivers to* MESSAGE CLERK.]

MESSAGE CLERK—Schenectady 8-0040.

INCOMING VOICE—[*Over loud-speaker*] Schenectady County Control Center.

MESSAGE CLERK—[*Slowly*] Albany County Control Center. Take a message to J. H. Burwell, Zone Water Co-ordinator. Seven sleeves and seven cylinders of chlorine as ordered from the Albany Water Department to be sent to Superintendent Wardle in Hudson will leave Albany in 10 minutes. Signed, L. Greenleaf.

INCOMING VOICE—To J. H. Burwell, Zone Water Co-ordinator. Seven sleeves and seven cylinders. . . .

NARRATOR—Let us now go back to the State Office of Civilian Protection. Devendorf is talking with Burwell.

STATE CO-ORDINATOR—Hello, John. How are you getting along?

ZONE CO-ORDINATOR—Fine, Devy. I sent two crews with repair trucks, 200 feet of 12-inch pipe and three 12-inch valves out of Schenectady about a half hour ago.

STATE CO-ORDINATOR—How about the sleeves and chlorine?

ZONE CO-ORDINATOR—Just got word through the Schenectady County Control Center that Cassidy will have this rolling through to Wardle in about 10 minutes.

STATE CO-ORDINATOR—That's fine. I just talked with Edinger in Kingston and he says a pump is on its way to Hudson now, so I guess Wardle is getting fixed up all right.

ZONE CO-ORDINATOR—It was surprising to me that Wardle should need any repair crews. He just got through training about 40 auxiliaries and they are humdingers. I saw them work out the other night and those volunteers made a repair and disinfected the repaired main at night all within a period of 55 minutes from the time the action started.

STATE CO-ORDINATOR—I know, John, but that was only one break during a practice run. Wardle has the real thing on his hands now. Even his 40 auxiliaries leave him a little short.

ZONE CO-ORDINATOR—I guess that's right. I think I'll figure on increasing the number of my own emergency crews somewhat.

STATE CO-ORDINATOR—Not a bad idea, John. Well, anyway, thanks for a swell job. I know that we can get prompt help from Wardle whenever we need it. Let me know of any developments.

ZONE CO-ORDINATOR—O.K., I'll get Erickson on his way to Hudson pretty soon. So long.

STATE CO-ORDINATOR—So long, John. [Hangs up.]

EDITOR'S NOTE: It is no less than astonishing to find in certain circles, recently, the tendency to advise the use of public mains to convey water known to be polluted for use at times of fire demand. Inter-system connections are strongly recommended. Use of independent industrial supplies of known safety is proper. But the use of public supply mains to convey unsafe water for fire fighting belongs to history—not to current policy. It has taken many years of advocacy and many adverse experiences to write into current thought the idea that public water supply lines be not used to convey water of unsafe sanitary quality. There is nothing in the open record of British wartime experience to indicate that they found such a procedure necessary. Therefore, we in the United States cannot justify—under present or reasonably forecast conditions—a policy of using public water supply lines to carry a *known polluted* water for fire fighting. Although, in this particular instance, the river water used as an emergency supply was presumed to be subject to *heavy chlorination*, practical water works men have reason to fear that, under emergency conditions, the polluted water might easily be used and the chlorination forgotten or delayed.

Public Water Supply Defense in North Carolina

By Warren H. Booker

THE more adequate protection of North Carolina's public water supplies as a civilian defense measure began to make progress on Monday morning, December 8, 1941, following Pearl Harbor on the Seventh. A general letter was written to the five State Board of Health District Sanitary Engineers, on December 8, in regard to taking immediate steps looking toward the better protection of our North Carolina public water supplies to withstand any emergency which might arise.

In looking back, it is interesting to note the great number of points stressed in that preliminary letter which are still being stressed. Some of these points are: increasing the chlorine residual; returning chlorine cylinders promptly; discouraging visitors at water works and filtration plants; taking every reasonable precaution against sabotage; stocking moderate supplies of chemicals and cast-iron pipe and fittings for possible emergency repairs; repairing all equipment, as far as possible, and laying in a reasonable supply of spare repair parts; providing fences, floodlights and guards for extremely vulnerable or strategic features; providing new fire hose, with adapters where necessary; providing maps and plans of valves and fire hydrants; studying each water works for its own special vulnerable points, and providing means of protection of these vulnerable points, as far as possible.

The letter ended with the admonition: "Let's follow this through and not get caught napping. Even if nothing untoward ever happens, the practice of keeping a great lot of these odds and ends gathered up will be very beneficial to us, to the water works authorities and to the public health interests of the state." This admonition with reference to water works is as true now as it was then. Another comforting thought in connection with water works preparedness work, which is probably also true to a very large extent with many other fields of civilian defense activity, is that 95 per cent or more of the work done is equally valuable during peacetime. Practically all of it should have been done before. Nothing is lost.

On December 10, 1941, another letter was sent out to the district sanitary engineers based on a telegram from the U.S. Public Health Service urging vigilance against sabotage, exclusion of visitors from water works, providing guards at danger points, and stepping up the chlorine dosage.

A paper presented on November 3, 1942, at the North Carolina Section Meeting, Durham, N.C., by Warren H. Booker, State Water Co-ordinator and Director, San. Eng. Div., State Board of Health, Raleigh, N.C.

On December 17, 1941, a general letter was sent to all mayors, boards of aldermen and water works authorities, urging action in many matters of general preparedness of water works to meet any emergency.

Mutual Aid Plan

There followed vigorous efforts on the part of district sanitary engineers to secure compliance with the suggestions made. Conferences were held with prominent water works men and with officials of the North Carolina Section of the A.W.W.A.; and, in January 1942, steps were taken to get a Mutual Aid Plan under way in North Carolina, similar to those being undertaken in New York and Massachusetts. The public response to this Mutual Aid Plan was most gratifying. By the latter part of January 1942, Mutual Aid inventories from water works, large and small, were pouring in to the Division of Sanitary Engineering of the State Board of Health in large numbers.

Despite automobile tire and gas problems, it was decided, with the co-operation of Dr. H. G. Baity of Chapel Hill and several foresighted water works men, to call a state-wide meeting of water works and municipal officials at the Institute of Government at Chapel Hill for a one-day session on January 28. To this meeting were also invited key men from adjoining states.

The attention and attendance at the meeting were beyond all expectations; in fact, the attendance was so large that it was necessary to transfer the sessions to larger quarters. Principal features on the program, presided over by T. S. Johnson, at that time State Director of Civilian Defense, included discussions of bombing, sabotage, civilian defense, mutual aid and other wartime problems, by leading authorities in the various fields.

Since that meeting, the author, as Director of the Division of Sanitary Engineering of the State Board of Health has been appointed State Water Works Co-ordinator, and he, together with other State Board of Health engineers, has pushed the Mutual Aid program vigorously.

Preparedness Program

Later, a "Ten-Point Preparedness Program" was inaugurated and promoted in connection with personal visits by district sanitary engineers to municipal water works, wherever time and opportunity from routine duties permitted. Under this program are included, briefly, the following items:

1. Securing a Mutual Aid Plan inventory of water works men, materials and equipment available for emergency service
2. Selling or exchanging excessive reserves, such as pipes, fittings, pumps, motors and other equipment
3. Increasing water works auxiliaries by connection to other municipal water supplies, to safe industrial supplies, to safe private supplies; by providing other auxiliary sources of raw water; by arranging to use non-potable water for fire protection only, should the emergency require; and by providing sources of auxiliary power for pumping and operating water works equipment
4. Locating, testing and making usable all gate valves and fire hydrants
5. Getting plot plans of the water, distribution and the sewer collecting systems
6. Forming emergency organizations and integrating them with the Office of Civilian Defense and emergency

training of auxiliary water repair crews

7. Keeping in a high state of repair, maintenance and efficiency all water works equipment, such as, pumps, motors, chlorinators and filtering and other mechanical equipment

8. Studying the matter of personnel, including close checks of loyalty and trustworthiness, nationality and the likelihood of sabotage of water works by present or former disgruntled employees and others

9. Taking miscellaneous precautions, such as fencing, floodlighting, guarding, locking of doors and gates to water works property, exclusion of visitors, blackout precautions, increased chlorine residual and better police vigilance

10. Studying carefully and confidentially the vulnerable points, such as remote dams and reservoirs, exposed pipelines, transformer stations, intake structures and unprotected or open reservoirs; and, finally, enumerating recommendations with reference to all points, except the vulnerable points, which are considered confidential and are discussed only in person with water works and municipal officials.

Materials and Repair Problems

After going over this program with the officials in charge, formal reports were made and filed with municipal and water works officials. As the result of this effort, 80 of the most strategic and important towns have been canvassed, formal reports prepared and much excellent work has been done toward placing these water works on a better defense basis. It is planned to visit and report on approximately 30 more public water supplies in the near future. Valves have been located, repaired and spotted on maps. Maps of distribution systems have been prepared, revised and brought up to date. A reasonable supply of reserves for repair in emergencies has been stocked by a great many water works, and, in general, the water works in North Carolina are now far better prepared to withstand an emergency than they have ever been before.

As critical materials problems increased, the War Production Board began curtailing their purchase. In July, a meeting of representatives of the North Carolina Section of the A.W.W.A. convened and directed the State Co-ordinator to prepare a surplus materials inventory of all water works in the state serving populations of over 5,000. This was done, with the result that a master inventory, showing approximately 500 tons of pipes, specials and other surplus equipment available in these towns, is now available. So great was the interest manifested by smaller water works, that it was decided to extend the inventory to include all water works in the state. A compilation of this second master inventory was completed as of October 30, 1942. In it are listed approximately a thousand tons of pipe and fittings; a great many motors and pumps; lead, copper and brass tubing; valves; hydrants; and much other available surplus water works materials. It is expected that water works of the state will, to a large extent, have to live on this "fat," for the duration. For this reason, every effort is being made to conserve the material for use within water works circles, and to use as small an amount of it as possible, with the thought in mind that it may be more and more difficult to get materials of this kind from factories and foundries at a later date.

The next step which has been considered, and which it is hoped to undertake shortly, is the matter of training water works emergency repair crews at various strategic points throughout the state. This work it is hoped to undertake in co-operation with Prof. Albert Coates of the Institute of Government. By reason of Prof. Coates's recent illness, however, it has been necessary to postpone this undertaking for the present.

Summary

North Carolina water works have come a long way during the first twelve months of war. As far as can be learned, it is believed that they are far ahead of the water works of any other southern state, and well abreast of those of New York, Massachusetts and other states in danger zones.

As indicated in the first general letter under date of December 8, 1941, "even if nothing untoward ever happens, this practice of keeping a great lot of loose odds and ends gathered up will be very beneficial to us, to the water works authorities, and to the public health interests of the state." It is just good business and good common sense to be prepared. The more of these civilian defense measures taken, the better water works will be prepared, not only for war emergencies, but for any peacetime emergencies. It follows, then, that there will be less likelihood of interruption to the regular business routine of providing an abundant supply of clean, safe, wholesome water for drinking and domestic purposes, as well as for fire protection, throughout the public water supplies of North Carolina.

Appreciation is expressed for the splendid co-operation to the water works of the state, for the advice and assistance of the officers of the North Carolina Section of the A.W.W.A. and, more especially, for the interest, assistance and encouragement of the State Director of Civilian Defense, Ben E. Douglas.

The Mutual Aid Plan in Indiana

By Louis A. Geupel

THE Mutual Aid Plan is not in itself a new plan, but one which most large water departments and companies carrying large stocks of materials have always carried on in their own districts as co-operative neighbors of the smaller plants nearby. In all discussions, the Mutual Aid Plan brings to the wide-awake water utility superintendent and operator the important realization that such a plan can operate only among water works men who are really friendly, who are willing to co-operate, who think alike and have similar problems, who realize the value of association and of "talking it over," who do not know it all, who will not take advantage of a friend who calls upon them for help, who will do everything to forget any seemingly political interference and who will do their share when called upon for service when the catastrophe or emergency occurs in a neighbor's plant.

It should be stated emphatically, here, that the Mutual Aid Plan applies only to catastrophe or dire emergency and most certainly not to materials or equipment forgotten or omitted from loose or hurried layout designs of new construction or extensions made under the stress of using critical materials. At the same time it should be understood that those who welcome and sponsor the Mutual Aid Plan emphasize the value of friendly and co-operative association among water works men and indicate their willingness to help and to serve in the case of catastrophe or serious emergency, even at some sacrifice of inventory.

1937 Flood Emergency

In January and February 1937 there existed a serious catastrophe and emergency along the Ohio River and its tributaries. The flood datum for which all protective works were constructed was shattered generally in the entire Ohio River Valley and had to be raised about seven feet at Evansville, Ind. The cities along the Ohio had no idea or warning that the flood would occur but, even if they had had three weeks warning, necessary preventive and protective works could not have been constructed. Every water works man realizes the seriousness of that flood emergency even today and it happened six years ago.

During that flood emergency, everybody wanted to help and did help to a great extent. Everything was done that possibly could be done. The U.S. Public Health, the State Board of Health and other organizations all came in and gave advice which was more than helpful. The local water works

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A paper presented on October 20, 1942, at the Kentucky-Tennessee Section Meeting, Paducah, Ky., by Louis A. Geupel, Supt., Water Works, Evansville, Ind.

personnel was supposed to be self-sustaining, but with its back up against the excessively high water stage, it found it was not self-sustaining. Outside agencies, who perhaps did not know the city or the water superintendent's difficulties, then took over the problem. Usually, the superintendent was so busy saving what he had or trying to repair some of the damage with an inadequate staff that he had not time to attend the meetings of the emergency agencies or even to register with them. Consequently, he had to work on his own initiative and without the authority to commandeer boats or other equipment that he needed.

Indiana Emergency Subcommittee

At about this time, the Indiana Section formed its Technical Committee for the purpose of working out the theoretical as well as practical problems most frequently discussed at section meetings and not covered in the studies of the Association as a whole. The Technical Committee was formed under the leadership of F. C. Schaefer of New Albany. As important problems developed or information was needed, subcommittees of the Technical Committee were appointed and, as among friends, information was assembled and detailed reports submitted. Pavement repairs, depth of frost, types of water pipe, etc., were investigated. One of the subcommittees appointed was the Emergency Committee, with the author named as chairman. One of the first steps of the Emergency or Disaster Subcommittee was to attempt to inventory the plants of the state with respect to materials in stock, equipment, such as diggers, temporary pumps, compressors, on hand, and contractor's equipment generally used in the vicinity.

The Emergency or Disaster Subcommittee divided the state into nine sections or zones acceptable to the State Board of Health and named Section Chiefs who were to gather the information as requested by the Subcommittee and to give progress reports on the information obtained with supporting data. [See Jour., A.W.W.A. **33**: 1079 (1941) for the author's report of the first year's activities.] The Section Chiefs were to visit the water works men in their section, develop friendly co-operative relationships and obtain the needed data. The stumbling block was that under a voluntary co-operative venture the scheme of obtaining inventories of private plants did not succeed, as many of the larger plants did not see the necessity of giving their inventories out as a public venture, to have them compiled in a grand summary for everyone's scrutiny. The latest result before war was declared showed a voluntary report of about 40 per cent of the water utilities, even though the results obtained were to be held confidential.

Wartime Reorganization

During the year 1941–42, the author was made chairman of the Indiana Section of the A.W.W.A. and during this period the Emergency or Disaster Subcommittee of the Technical Committee, under the stress of the war emergency, was officially advanced to the status of a separate committee, the Emergency Water and Sewerage Committee, operating directly under the Indiana Section's control. The author might say that "Sewerage" was added to the Emergency Water Committee in co-operation with Sewage Works Association and at the request of the Indiana State Board of Health. This important Emergency Water and Sew-

erage Committee is a 10-man committee with a personnel of tried practical men taken from all phases of water works operation, construction and maintenance work. The prime work of this committee is to co-operate with and assist the plant personnel under stress, but as a last resort the committee representative may take over if the need occurs.

Everyone realizes that the bombing of Pearl Harbor changed the aspect of all walks of life in this country. The former subcommittee working on a voluntary co-operative basis thus graduated into the main 10-man Emergency Water and Sewerage Committee of the Indiana Section and through the efforts of B. A. Poole, State Sanitary Engineer, and M. H. Schwartz, General Manager of the Vincennes Water Department, as chairman, was officially recognized as the Emergency Water and Sewerage Committee of the Indiana State Defense Council, the Indiana State Board of Health and the State Police. Each committeeman was sworn in and given a photograph pass and certification endorsed by the Chairman of the State Defense Council, State Health Commissioner, and the Superintendent of the Indiana State Police. The State Defense Council assigned to this emergency committee the responsibility of safeguarding public water supplies.

Mutual Aid Inventories

The members of the committee in friendly co-operation pledged themselves to this program of preparation, and also promised to aid stricken communities by physical assistance if possible. The main duty during the last few months has been to serve actively in an advisory capacity and to carry on with the Mutual Aid Plan so that water works men could help themselves or each other in case of disaster. In part, this program has included the issuance of special State Defense Council Bulletins, on plant protection and rehabilitation of water main systems, the establishment of the nineteen zones, the appointment of the zone co-ordinators, the collection of information concerning existing inventories of available equipment and materials of all water works systems under authoritative order and the holding of a special school at Purdue University for water works officials. (See Jour. A.W.W.A., **34**: 1889 (1942) for a condensed and slightly revised reprinting of this Committee's Bulletin No. 3 on emergency main repairs.)

The Mutual Aid Plan was determined to be the best procedure for obtaining equipment and materials in case of serious emergencies during these times of material shortages and priorities. As has been done in other states, the inventory forms were sent out by the co-ordinator to each water plant in his zone. A letter of explanation accompanied this form, and in many cases, the co-ordinator called at the water plant in person to explain the procedure and to help make out the inventory. All representatives of the State Board of Health aided in getting these inventories to the co-ordinator.

The inventories were forwarded to the Indiana State Board of Health in confidence for re-typing. A summary form to include all equipment and materials in each zone has been devised and the information from inventories transferred to a summary form. One copy of the inventory form is sent to the co-ordinator, one copy returned to the water works, and the original is retained in confidence in a locked, fireproof file of the State Board of Health.

Functioning of Mutual Aid

How is the Mutual Aid Plan to function in disaster? Since it is imperative to maintain water service, it naturally becomes necessary to repair breaks of major consequence at once. No matter how many other agencies of fire wardens, fire fighters, rescue squads, demolition gangs with insigne, armbands and organization charts, none can put out major fires without water. Every water works man should ask his local Civilian Defense Director what armbands will be received for the ditch digging and pipe repair crews who repair the breaks to water mains so other trained organizations can fight the fires. Perhaps no armbands for the water utility workmen will be found. Assuming that a city did not have the necessary equipment or materials to make all these major repairs in the minimum time, the superintendent of this stricken plant immediately should notify his zone co-ordinator of the details of the disaster and request help in securing necessary materials and equipment for the immediate repair of the mains. The zone co-ordinator in turn would examine his file of inventories from the towns in his zone to see where he could best obtain this material.

If the material is available in any of the water plants within his zone he would call the appropriate superintendent and ask that the necessary equipment or material be loaned to the stricken city. If the necessary material is not available in towns within his zone or cannot be spared at that time, the co-ordinator would get in contact with the Bureau of Sanitary Engineering of the Indiana State Board of Health. The chief engineer, or his appointed representative, would then examine the master file to see if the materials under question could be obtained in an adjacent zone. Through this process, the stricken city would in a very short time be supplied with the materials and equipment to repair the water main breaks.

Training Auxiliary Personnel

In conjunction with the Indiana Defense Council, the emergency committee is preparing to initiate in-service training courses for all water works personnel. This training is to have the following objectives:

1. To encourage preparation for emergencies by keeping distribution maps up to date and by following regular valve and hydrant testing programs.

2. To show the water works superintendent the possible need for utilizing auxiliary private or industrial supplies in cases of emergency. The superintendents have been asked to assemble a list of all such possible auxiliary supplies together with a bill of materials needed to connect them to the public distribution system.

3. To train auxiliary personnel in the fundamentals of distribution system repair.

The above objectives were discussed in detail at the two-day water works school, devoted to wartime emergencies, held July 16 and 17 at Purdue University. At this meeting approximately 125 water works officials, including all the zone co-ordinators and the emergency committee, convened to hear discussions concerning several civilian defense problems, particularly as they affect the water works.

It is stated that our national success in this "World War Emergency" lies in a program of intelligent co-operation

between the civilian population and the armed forces. There is a place for every American in civilian defense where he can serve on the home front. Water works men should use their intuition and must develop their own observers. The civic program of the Boy Scouts of America may be appraised, for as a local organization Boy Scouts can help report leaks and such other items as open valve boxes. We must mention as we have mentioned before, and as the British have found out, that you can not compel volunteers to dig in muddy holes to repair broken water mains; therefore, diggers must be paid regardless.

We hear that the Mutual Aid Plan is interested in the organization and training of auxiliary crews. Auxiliaries are being trained as firemen and policemen in nearly every municipality of the state, whether large or small, and if civilian defense workers are needed in these fields the water works certainly cannot assume that their regular personnel will be sufficient to handle all emergencies.

The water works men must continue to look ahead, planning as best he can. He very seldom has an advisor to whom he can go in his town; even his family is prone to argue with him because he works all the time; even the Government asks for his quarterly inventory and tells him he has too much on hand by X per cent. On one side they say get down to the 1940 inventory of the days of peace and complacent living; and on the other side along comes Civilian Defense, and the reading and pictures of British cities with 500 water main breaks in two hours. There seems to be only one thing to do, and that is to be cooperative and friendly with those men who are planning to meet the same problems as you and who have the same miseries you have. Remember though that regardless of the emergency, regardless of the broken mains, the water works men do not shift their responsibility of delivery of water, and safe water, so think seriously of helping yourselves and study that Mutual Aid Plan.

The Civilian Defense Program in Virginia

By J. H. Wyse

WHEN water facilities fail, everything fails. The enemy realizes this and makes water works installations a primary target for bombing. A few of the casualties of the present war—Warsaw, Hongkong, Singapore—make this fact apparent. The first indication of the downfall of these strongholds was the collapse of their water systems. The most serious damage to Coventry was the loss of its water supply.

Bombing of these public water works was not a chance occurrence. These targets were singled out specifically by the enemy. The length of time any place can withstand a siege is in large part dependent on how long its water supply will last.

To outline the workings of the civilian defense program in Virginia and to indicate how it is related to the activities of water works men, the author proposes to present a short résumé of its organization.

A Virginia defense council was created by an executive order issued by the Governor on May 30, 1940, only two days after President Roosevelt created the Advisory Commission to the Council of National Defense. It should be remembered that during this early period of organization there were no laws authorizing special rules and regulations for local defense councils except the authority granted to the Governor to issue executive orders. During the time between the creation of the council and the enactment of enabling legislation, however, a number of worthwhile things were accomplished. Among these was a memorandum sent out in July 1942 to all utilities in the state, advising the owners, whether private or public, to take steps to prevent sabotage and make plans for emergency repairs in the event of enemy action.

Most of the owners replied to that memorandum, indicating that plans either had been made or were being made. In many cases, guarding of dams and valve and distribution systems was initiated as a result of the order.

Enabling Legislation

The need for specific legislation was clearly apparent by the time the General Assembly met in regular session early in 1942. The principal defense act, approved February 11, 1942, is entitled "An Act to declare the existence of an emergency and to provide for the co-ordination of civilian defense activities; and to this end to designate the Governor as Director of civilian de-

A paper presented on November 5, 1942, at the Virginia Section Meeting, Richmond, Va., by J. H. Wyse, Co-ordinator, Virginia Office of Civilian Defense, Richmond, Va.

fense and to prescribe his powers and duties as such."

This defense act is different from those of other states that have enacted defense legislation in that it does not make mandatory a state defense council. It is optional with the Governor whether or not he shall appoint one, but in the event that one is appointed, the legislation confines its members to heads of state departments. So far the Governor has not seen fit to create a state council, depending instead upon the Office of Civilian Defense for a program of protection.

Local defense councils, however, are mandatory, as provided in Section 6 of the act:

"*Local councils.* (*a*) There shall be a local council of defense, as hereinafter defined, in each county, city and town in the state; provided, however, that, in the discretion of the Governor, one local council may be established for a county and any city or town, located within the territorial boundaries of such county.

"(*b*) For each local council there shall be a director of civilian defense, who shall be as follows:

"(1) In the case of a city of the first class, the director shall be the mayor, or chief executive officer of the said city who shall have the authority to appoint a co-ordinator.

"(2) In the case of a city of the second class or incorporated town, the director shall be the mayor, who may, by and with the consent of the city or town council, appoint a co-ordinator.

"(3) In the case of counties, the boards of supervisors, or other governing body of a county, shall elect a director, who, by and with their consent, may appoint a co-ordinator.

"(4) In the case of a local council established for a county and any city or town within its territorial boundaries, the director, who shall also serve as co-ordinator, shall be designated by the chairman of the board of supervisors, or other governing body of the county, and the mayor or mayors of the city or town.

"(*c*) The membership of a local council of defense shall consist of such persons, resident of the locality for which the council is established, as shall be appointed by the local director.

"(*d*) It shall be the duty of each such local director of civilian defense, and of each local defense council established pursuant to this act, within the programs of activity prescribed by the Governor, to engage in such activities and perform such functions and duties as will further the defense of the locality and the State."

Action Taken

It will be noted that under this legislation, the local authorities are responsible for the organization of local defense councils and for setting up protective measures to protect their population during and after bombings. Those charged with its enactment kept in mind that local constituted legal authorities in municipalities, towns and counties are responsible for the protection of their own people. If they fail to take proper precautions, the failure rests on their own shoulders. It has always been the policy of the Virginia Office of Civilian Defense to use regular constituted agencies in carrying out the plans and programs of civilian defense and it is planned to continue this policy. In the final analysis, such authorities are the only ones that have the power to take the required action.

Pursuant to this legislation, there have been created 163 local defense councils. Each of these councils has a

Citizens Defense Corps, which, in the larger cities and towns, embraces such activities as police, fire, air raid wardens, emergency medical services, utilities, public works and emergency feeding and housing.

An air raid warning system has also been organized, comprising: 401 observation posts, scattered over the eastern and central parts of the state; 26 warning districts, manned on a 24-hour basis; and 225 direct-connected control centers, with 155 other 24-hour service points that are warned from the district warning centers. These fan out and cover the entire state, except the ten far southwest counties, and give warning of an approaching air raid.

If a locality has carried out instructions and has organized as recommended, a representative of the water works system should be within every control center during a raid.

No attempt will be made to discuss in detail the overall plans for air raid precautions. This is a matter to be determined by each locality. The Office of Civilian Defense does, however, send out pamphlets and information that cover the detailed plans very completely. If all of the precautions suggested in these pamphlets that are applicable to a particular locality have been followed and if the volunteer personnel has been trained and drilled properly, it will be possible to reduce loss of life and property damage to a minimum in any emergency. Plans, training and supplies cannot be organized during or immediately after an air raid. Unless the planning has been thorough, only confusion can be expected.

Abstracts of Water Works Literature

Key: In the reference to the publication in which the abstracted article appears, **34:** 412 (Mar. '42) indicates volume 34, page 412, issue dated March 1942. If the publication is paged by the issue, **34:** 3: 56 (Mar. '42) indicates volume 34, number 3, page 56, issue dated March 1942. Initials following an abstract indicate reproduction, by permission, from periodicals, as follows: *B.H.—Bulletin of Hygiene (British); C.A.—Chemical Abstracts; P.H.E.A.—Public Health Engineering Abstracts; W.P.R.—Water Pollution Research (British); I.M.—Institute of Metals (British).*

HEALTH AND HYGIENE

New Light on the Relation of Housing to Health. R. H. Britten. Am. J. Pub. Health **32:** 193 (Feb. '42). Author bases conclusions on certain statistical data, collected in the National Health Survey, house-to-house census of illness and medical care, in relation to economical and social factors, made by the U.S.P.H.S. in '35–36, covering 2½ million persons in 83 scattered cities: (1) *Association of common communicable diseases of childhood with crowding:* Following groups compared: (a) households with 1 person or less per room; (b) households with more than 1 person, but not more than 1½ per room; (c) households with more than 1½ persons per room. Generally incidence rate, particularly in diphtheria and mumps, proved to be much higher in crowded houses. Most striking feature in series of charts is definite evidence of increased tendency for diseases to occur at lowest ages, i.e., in 1–5-yr. old group in crowded households, at period when these diseases, particularly measles and whooping cough, most dangerous. (2) *Crowding and illness, family income taken into consideration:* As sharp contrast, low income (relief) group, with more than 1½ persons per room, compared with all income group of 1 person or less per room. Excess for tuberculosis 350%, for pneumonia 150% and for rheumatism 100%. In case of tuberculosis, secondary attack rate was 3 times as great in crowded group. (3) *Absence of sanitary facilities in relation to incidence of digestive diseases:* Exact comparison between houses of different rentals and values with and without private water-closets, 3 groups of diseases selected being indigestion and similar ailments, diarrhea and enteritis and typhoid fever. Actual incidence rates in each group of diseases considerably higher in poorer class houses. Charts also show high incidence of digestive diseases in houses without internal water carriage, particularly in typhoid group of diseases, where incidence practically double. (4) *Relation of home accidents to houses of different value:* Charts show appreciable increase in frequency of accidents in lowest rent houses, most marked being in group inhabiting rented multiple dwellings. Charts thus suggest greater accident hazard due to poor housing. Vicious circle emphasized—"This excess illness rate, in whatever degree it is to be ascribed to bad housing, occurs in low income, poorly housed populations, who are least able to meet burden of disease."—*B.H.*

Water in Relation to Health. T. N. S. Raghavachari. Indian Med. Gaz. **76:** 233 ('41). Defines following terms as applied to water: safe, potable, polluted and contamd. Been proved that reactions of coliform bacteria to certain tests specific in temperate regions different in tropics. Storage of river water for more than 5 days led, in India, to increase in bacteria and in algal growths. Although water impounded in reservoirs in India generally does not contain nitrites, nitrates or phosphates, algal growths occur and cause difficulty in treatment. Small quants. of inorg. substances normally present in natural waters usually physiologically innocuous though may affect color, odor, taste and turbidity. Physiological effects of hardness, caustic alky., sodium and potassium salts, metals such as copper, aluminum, arsenic, iron, zinc, etc., and fluoride in water discussed.

Generally, substances contained in water too small in amt. to have any physiological effect and, except when some absorbable poison present, water for drinking requires only bact. purif. Palatability and cooking properties good guides in selection of source of supply. For other purposes, such as washing, however, such constituents as hardness of importance. —*W.P.R.*

The Effect of Mineral Water on Kidney-Function Tests. R. O. Muether, G. T. Flynn & R. A. Mezera. J. Missouri State Med. Assn. **39:** 45 ('42). Use of mildly alk., non-carbonated, natural mineral water as source of fluid for human being results in increased excretion of injected dye (phenolsulfonephthalein) and of urea. In case of severe gout, uric acid content of urine increased consistently. On whole, excretion of phenolsulfonephthalein lowest when tap water used as test water; somewhat higher when distd. water used, though lower than with mineral water. Urea clearance lower with distd. water than with either tap water or mineral water. Chem. compn. of mineral water used (supplied by Mountain Valley Water Co.) and of tap water given. Compn. of mineral waters varies so widely in different localities that this study cannot be taken to apply to all mineral waters without specific detns. as to whether or not they can improve excretion. Effectiveness of mineral water in improving excretory powers of kidneys for certain substances cannot be taken as evidence *per se* that such water has therapeutic properties.—*C.A.*

U.S. Public Health Service Emergency Sanitation Projects. Anon. Mil. Surgeon **91:** 709 (Dec. '42). 48 emergency sanitation projects involving more than **$1,000,000** now operating or pending approval, cover cities and counties in 22 states. Seven, involving **$150,000,** operating in N.C., Tex., W.Va. 32 pending in Tex., where Army air fields and camps have complicated local community san. facilities. Lack of critical materials compelled substitution of "basic sanitation" projects for more permanent installations. Four types included under present program: (1) Protection of wells and springs constituting semi-pub. water supplies and manual chlorination of small emergency water supplies. (2) Provision for safe disposal of body wastes through constr. and repair of san. privies, septic tanks and other disposal facilities. (3) Operation of facilities for san. collection and disposal of garbage. (4) Control of typhus fever, rising rates of which, in certain areas near Army camps in Southern States, noted. State health authorities requested control measures be undertaken. Federal agencies and state health depts. agreed to expedite allotment of funds for emergency projects.—*Ralph E. Noble.*

Sanitation of Construction Areas on the Delaware Aqueduct. F. A. Marston. J.N. E.W.W.A. **55:** 166 ('41). Describes san. provisions in areas on which work proceeding for constr. of Delaware aqueduct for requirements of workers and for protection of dwellers in area and of reservoirs. Water supplies for workers obtained from local public supplies, reservoirs, nearby streams, Catskill aqueduct and wells, or by transport to storage tanks at work. All water except from public supplies chlorinated. Chemical closets provided, or water-flushed closets draining to existing sewers or to sewage treatment plants. Most of sewage treatment plants comprise septic tanks, intermittent sand filters, chlorinators for effluent and small open sludge-drying beds. Sewage warm and weak and content of grease low. Avg. flow 25 gpd. per man, but variations considerable. Diagrams of typical plants given. Turbid ground water pumped from excavators and surface drainage from constr. areas passed through settling tanks and chlorinated before being discharged. Rock excavated from tunnels chlorinated before being dumped on shores of reservoirs. Since work begun in '36, no outbreak of water-borne disease has occurred.—*W.P.R.*

Public Health Engineering in British Columbia. R. Bowering. Can. Engr.—Wtr. & Sew. **80:** 8: 23 (Aug. '42). Activities of Public Health Eng. Div. of Provincial Bd. of Health reviewed. Provincial police force, whose officers ex-officio san. inspectors in unorganized territory, render valuable assistance. Water supplies of good qual. easily obtainable from mountainous watersheds of province by gravity and, as watersheds usually uninhabited, chances of dangerous poln. relatively remote. In several instances, watersheds set aside as health dists. by order-in-council and guarded continuously by san. inspectors, admission being secured only on presentation of certificate of freedom from water-borne disease. Kelowna only city in province delivering chlorinated water to consumers, equip. having been installed in '40.

Most large communities have public sewerage systems, but relatively few treatment plants, most of sewage being disposed of by discharge into salt water or large rivers.—*R. E. Thompson.*

The Action of a Chlorinated Water Supply Upon Lead Pipe. GEO. G. SCHAUT. Am. J. Pharm. **114:** 241 ('42). Alky. of water touching new Pb pipe played important role. During short contact period (up to 3 hr.) other factors as temp., Cl and time being nearly const., any change in alky. not reflected in Pb dissolved by water, whereas, when time interval lengthened to around 24 to 48 hr., then in case of winter water, doubling alky. almost doubled Pb content. With summer water, increase in Pb due to increased alky. not quite so pronounced, chiefly because of rapidity with which higher temp. water naturally acquires Pb from pipe. Study of values for varying alky. upon Pb service pipe reveals little different situation. Trend same, for when water is at min. temp., doubling alky. produces only small increase in Pb—far from double. As temp. rises, change in alky. produces even less noticeable variation. Probably accounted for by fact that white coating in old service pipe basic carbonate of Pb and rather passive to range of alky. found in water used. With alky. and residual Cl const. and allowing contact time of 8 hr. in new Pb pipe in ground, relation between water temp. and Pb brought into soln. by water proved to be straight line for several points when plotted on cross-section paper, with extremes showing that doubling temp. doubled Pb value. Undoubtedly combination Cl and warm water dissolve more Pb than water would without Cl. When summer water contg. Cl remains in new Pb pipe, Cl dissipated at rate depending chiefly upon temp., other factors being equal or nearly so. At time when Cl becomes almost nil (1 hr. for summer water) water then has acquired Pb content equiv. to formation of $PbCl_2$. At time residual Cl becomes nil, for new Pb pipe under all temp. conditions, const. Pb value acquired by water found, namely 0.38 ppm. as Pb. This value deducted from any Pb values beyond this point probably gives Pb values that water itself could acquire without Cl. In case of old Pb pipe, under two conditions studied, up to 3 days' contact, Pb value did not come up to 0.38 ppm. value as shown in Pb-soly. curves. With alky. and Cl const., and allowing contact time of 8 hr. in old Pb service pipe, water temp.-Pb relation shows that from 40° to 70°F. only a 50% increase in Pb dissolved by water. Unpublished data in possession of author convince him that it is almost straight line, and, for all practical purposes could be assumed between these points. Beyond this temp. fixed value for Cl, i.e., 0.12 ppm., could not be obtained for reasons cited before. To say what Pb value would be at max. temp., if 0.12 ppm. of Cl also present, for old services, can be matter of conjecture. Cl contributes its Pb equiv. about equally (on percentage basis) in old and new Pb pipe at max. water temp. If this accepted then one might be justified in saying that, for water at max. temp. with no Cl in new pipe in ground, proposed curve might be midway between that of summer water in new Pb pipe in ground and winter water in new Pb pipe at room temp. From this, observed that even without Cl new Pb pipe imparts Pb quite generously to water when at max. temp.—*C.A.*

How Toxic Is Arsenate of Lead? I. D. CARDIFF. J. Ind. Hyg. Toxicol. **22:** 333 ('40). Describes investigations on effects of lead arsenate on human beings and on growth of certain plants. Adult male human being kept under observation for period of 50 days, during which time he consumed daily quants. of lead arsenate ($PbHAsO_4$) ranging from 0.0115 to 0.8 grain and amtg. in all to approx. 30 grains. Clinical examn. did not indicate that lead arsenate had any appreciable effect on health of subject. Expts. showed that many algae, fungi and bacteria unaffected by lead arsenate in concns of ½ to 5% in tap water. Suspensions of ½ to 15% in tap water appeared to have no inhibiting effect on germination of seeds. Presence of hydrochloric acid in concn. of ½% or of sodium chloride did not increase toxicity of suspensions of lead arsenate. Growth of yeast (*Saccharomyces cerevisiae*) in 1 ml. of a 2% soln. of sugar not inhibited by addn. of 1, 3 or 6 drops of 15% suspension of lead arsenate. Expts. in which lead arsenate applied directly to soil showed that, with onions grown from bulbs, growth and development stimulated by presence of 112 grains of lead arsenate per cu.ft. of soil, but were retarded by higher concns. Certain plants appear to be able to assimilate arsenic from deposits of lead arsenate in soil. Daily consumption by cow of approximately 100 grains of lead arsenate had no effect on cow and did not appear to increase concn. of arsenic in her milk.—*W.P.R.*

A Parthenogenetic Chironomid as an Infection in Water Pipes. F. KRUGER. Naturwissenschaften (Ger.) **29:** 556 ('41). Under normal conditions, when female midges lay their eggs in service reservoir, organisms carried into distr. system do not spread, as adults cannot escape into air for mating. In one instance, however, larvae of a species of midge found continually in distr. system, and were not destroyed by cleaning and drying service reservoir. Therefore evident that development taking place in water pipes and that either pupae capable of mating or that organism was parthenogenetic and mating unnecessary. Examn. showed no opening in pupa for extrusion of sex products, so concluded that parthenogenesis took place. Organism assigned to genus *Stylotanytarsus*, known to be parthenogenetic. Organisms require oxygen and had found a suitable habitat in distr. system. In July '39, 50–60 larvae per l. were found. During course of investigations 8 generations developed parthenogenetically, and males did not appear during observations over period of 3 yr. Contact with pyrethrum powder for 48 hr. did not destroy larvae. Food and chem. and phys. conditions affecting larvae investigated in attempt to find method of control. Iron bacteria in water pipes provide food supply. Attempts made to end parthenogenetic cycle and produce males by altering temp. but with no success. At first thought that it might be increased pressure in distr. system which had induced parthenogenetic reproduction, but later known that parthenogenesis obligatory in *Stylotanytarsus;* therefore not possible to destroy organism by reducing pressure and bringing about normal reproduction. Leaving service reservoir dry, and flushing distr. system, eventually eradicated midges after 2 yr. Previous attempts unsuccessful, as small pockets had been left which acted as centers of infection.—*W.P.R.*

The Common House Fly as a Source of Pollution in Food Establishments. M. OSTROLENK & H. WELCH. Food Res. **7:** 192 (May–June '42). House fly maggots obtained from manure heap and then bred for several generations in a medium of bran-alfalfa meal, malt and yeast. Washings from surface of flies reared from this culture yielded total bacterial counts of 2,500,000 to 29,500,000 per fly. *Aer. aerogenes* bacteria present in amts. representing 84,000 to 2,000,000 bacteria, *Esch. coli* in considerably reduced numbers, particularly after several generations. When sterile foods exposed to these flies, very quickly became contamd. with bacteria. Authors stress menace of even small numbers of flies in food-producing establishments.—*B.H.*

Flies as Carriers of Poliomyelitis Virus in Urban Epidemics. A. B. SABIN & R. WARD. Science **95:** 590 (Dec. 19 '41). Knowledge that virus of anterior poliomyelitis present in feces led to investigation of flies as vectors of infection. Recently Paul and collaborators isolated virus from flies caught in two rural areas where cases had occurred [*cf.* following abstract] and authors have obtained positive results with flies caught in urban sites during outbreaks at Atlanta and Cleveland. Virus obtained from flies extracted by means of ether and injected intraperitoneally into a Cynomolgus, and unetherized material administered intranasally and orally. Paralysis developed on ninth day and on second passage on fifth day. Lesions produced typical. In another expt. first inoculated monkey became paralyzed on fifteenth day and passaged monkey on the sixth day. In authors' words: "Ease with which poliomyelitis virus can thus be isolated from flies caught in urban areas (where immediate contamn. with feces in open privies at least not obvious) suggests that they may play important role in transmission of virus and may perhaps be responsible for special seasonal incidence of disease." Question of actual multiplication of virus in the insects not yet detd.—*B.H.*

The Detection of Poliomyelitis Virus in Flies. J. R. PAUL, J. D. TRASK, M. B. BISHOP, J. L. MELNICK & A. E. CASEY. Science **95:** 395 (Oct. 24 '41). Two instances recorded in which virus of poliomyelitis detected in collections of flies made in field during epidemics of disease. Collections included several different species. Suspension of flies, macerated in water, centrifuged, some of supernatant fluid being etherized for intraperitoneal inoculation and another portion, mixed with gauze-filtered fly washings, used for intranasal instillation. Cynomolgus monkeys used; they received intraperitoneal inoculation followed by intranasal instillations on 3 successive days. In each successful instance, monkeys developed typical signs and symptoms of exptl. poliomyelitis and showed typical histological changes in spinal cord. Virus strains passaged through other monkeys and shown to be non-infective for mice on intra-

cerebral inoculation. Four other attempts to recover virus from flies collected in epidemic areas unsuccessful.—*B.H.*

Mosquitoes and Static Water Supplies. ANON. Surveyor (Br.) **101:** 169 (May 22, '42). Owing to provision of numerous static water supplies for fire fighting, necessary to prevent them from becoming breeding place for mosquitoes. Of 30 species of British mosquitoes, 27 breed so rarely in tanks that they need not be considered. *Culex pipiens* breed in any kind of stagnant water, seldom if ever puncture human beings. *Theobaldia annulata* widely distributed in Britain. Fiercely attacks human beings and breeds almost exclusively in foul water. Unlikely to breed in water stored for fire fighting. *Culex molestus* closely resembles *pipiens* but is bloodthirsty attacker of humans. Knowledge of habits far from complete. Cannot yet presume that insect does not transmit disease. For slaughter in breeding places, spray with 2 to 5% soln. of carbon tetrachloride in kerosene oil, with 5% soln. of cresol disinfectant in water or with mixtures contg. pyrethrum [*see also* Jour. A.W.W.A. **34:** 1287 ('42)].—*H. E. Babbitt.*

Ants as Probable Agents in the Spread of Shigella Infections. SOPHIE DEHLER GRIFFITTS. Science **96:** 271 (Sept. 18, '42). Hitherto, ants not incriminated as vectors of bacteria pathogenic to man. During expts. on native food as culture medium for *Shigella*, found ants carry latter organisms. Before entering food supply in one container, expt. infected with *Shigella flexner* V., ants trapped and exposed to sterile MacConkey and S.S. agar plates. Latter sterile after 24 hr. Ants fed readily 4 hr. Food removed and sterile plates introduced long enough to allow ants to walk over surfaces. These plates produced *Shigella flexner* V. After 24 hr. feeding on infected material, sterile plates again introduced. These produced typical *Shigella* growth marking ant footprints. Process repeated in 48 hr. but no colonies appeared. 20 ants of this group then macerated and inoculated on plates, others placed in nutrient broth, again failed to produce *Shigella*. Repeated with like results. Deduced ants may carry bacteria on feet 24 hr. after feeding on or traversing infected material. Used tropical fire ants, *Solenopsis geminata* (*F*), common in Puerto Rico and found in practically every environment.—*Ralph E. Noble.*

Studies of the Acute Diarrheal Diseases. (Parts I–VIII *abstracted*, Jour. A.W.W.A. **34:** 1280 ('42).) *IX-A. Shigella Dysenteriae Infections Among Institutional Inmates.* ALBERT V. HARDY, REBECCA L. SHAPIRO, HARRY L. CHANT & MORRIS SIEGEL; *IX-B.* JAMES WATT, ALBERT V. HARDY & THELMA DE CAPITO. U.S. Pub. Health Repts. **57:** 1079, 1095 (July 24, '42). *Objectives:* Hitherto study of *Shigella dysenteriae* infections limited almost exclusively to observations on clinical cases and their immediate contacts. This inadequate to provide satisfactory epidemiological interpretation. Information needed concerning occurrence of these infections in healthy persons and those with clinically insignif. enteric disturbances. Chief obstacles to extending studies in these directions difficulty of isolating *Shigella dysenteriae* from normal stools and obtaining adequate nos. of satisfactory stool specimens for bact. examn. Recent introduction of highly selective media did much to elim. both problems. Desoxycholate citrate and S.S. (*Shigella-Salmonella*) agars not only increased proportion of pos. observations but permitted simple rectal-swab technique for obtaining and plating fecal material. Present study part of investigation of occurrence of *Shigella dysenteriae* carriers. Prevalence in gen. pop. could be measured by single or infrequently repeated stool cultures. Practical to exam. institutional inmates weekly or bi-weekly for long periods and thus observe behavior of these infections in course of time; also to study bacteriologically mild diarrheal disorders not coming to physician or health officer's attention in gen. pop. Major objective in this investigation to supplement data obtainable from study of gen. pop; minor objective to obtain better understanding of old problem of diarrheal disease among institutional inmates. *Findings:* Prevalence of *Shigella dysenteriae* infection among institutional inmates detd. by 13,356 survey stool cultures, of which 885(6.6%) pos. Prevalence in same group at different times varied from no detected infections to max. of 26% known infected at one time. Detected infections in different groups varied from none to max. of 36% pos. at one time. Different varieties of *Shigella* found in same and different groups. Observed course of *Shigella dysenteriae* (Sonne) infection in 2 groups described. Sonne infections maintd. by constantly changing group of transient carriers. Flexner infections not maintd. with same per-

sistence. Characteristically *Shigella* infections spread slowly. In 1 group, periods of more rapid spread and high prevalence alternated with intervals of little spread and low prevalence. Infection rates detd. for 2 groups through routine cultures at intervals of 2 wk. for 20 mo. Min. total annual infection rates in these groups, 87 and 115 per 100 inmates. Attack rates of clinical infections, 16 and 33, respectively. Thus, min. carrier incidence rates, 73 and 82 per 100 inmates per annum. Attack rates higher in newly-admitted individuals than in "senior" inmates. Ratio of clinical to subclinical infection found to vary with variety of *Shigella;* occurrence of preceding infections with same variety of micro-organism and age of individuals. Ratio of clinical infections to carrier states in 1 institution, 1 : 7 for Flexner and 1 : 24 for Sonne. Preceding Flexner infections conferred no detectable protection against subsequent Sonne invasions. Probable mode of dissemination in these groups through person-to-person transmissal of fecal poln.—*Ralph E. Noble.*

The Prevention and Control of Infectious Diarrheas Among Military Forces. Joseph Felsen. Mil. Surgeon **91:** 65 (July '42). Resumé of epidemiology of infectious diarrheas among civilian U.S. pop. shows: (1) majority of unclassified infectious diarrheas appear bacillary dysentery; (2) reported incidence of latter far exceeds any other specific infectious diarrhea; (3) san. and hygienic measures among civilian pop. in peacetime reduced typhoid measurably, while bacillary dysentery remains widely prevalent. Partly due to better recognition and reporting of latter disease since '37. *Drinking Water:* Vincent and Muratet state *Shigella dysenteriae* survives in sterilized impure water at 1° to 14°C., 10 to 13 days. In very impure water, survival somewhat less, 2 to 5 days at 22° to 28°C. In ice, survival 41 to 68 days. [Survival data less impressive without information re method of water sterilization.] From N.Y. City tap water sterilized by filtration, inoculated with 11 std. strains and kept at room temp., recovered *Shigella dysenteriae* after 6 mo. From sterile litmus milk, under same conditions, recovered organisms after 4½ to 6 mo. In filtered sea water, *Shigella dysenteriae* survived 2 to 5 mo. In frozen state, all 11 strains alive in sterile and unsterile tap water after 1 mo. Under natural conditions, sunlight, temp., and antibiosis of other bacteria probable factors. Author further discusses hazard from practical military viewpoint, then considers bact. diagnosis of infectious diarrheas, clinical aspects, and therapy (prophylactic, supportive and curative). —*Ralph E. Noble.*

Control of the Typhoid Carrier. Anon. Lancet (Br.) **243:** 460 (Oct. 17, '42). Chronic carrier most important factor in maintg. endemic typhoid and paratyphoid infections, and often source of epidemic outbreaks. Typhoid, though now rare in Eng., still responsible for much morbidity and mortality in America and many sub-tropical countries. In Eng., being supplanted by paratyphoid, increasing in prevalency in recent years and often in form so mild or atypical as to be clinically unrecognizable. Control or cure of carrier therefore essential to eradication of these diseases. Persistent convalescent and chronic carriers most often elderly married women over 40 yr. old. Gall bladder focus of infection in most enteric carriers and, so far, cholecystectomy only reliable cure. Chemotherapy, physiotherapy, bacteriophage, vaccines and alteration of intestinal flora consistently failed to cure. Sulfapyridine, sulfasuxidine, sulfaguanidine, sulfadiazine and mepacrine tried unsuccessfully but claims made for soluble tetraiodophthalein used for x-ray visualization of gall bladder.—*Ralph E. Noble.*

A Milk-Borne Typhoid Outbreak Traced to Dairy Water Supply. T. R. Meyer, Rosemary Phillips, H. E. Lind & L. M. Board. J. Milk. Tech. **4:** 123 (May–June '41). Study of outbreak of typhoid in city and county of St. Louis, where 26 cases involved revealed that contamd. milk supply source of infection. Examn. of causes revealed that dairy failed to comply with std. milk ordinance for wholesaling milk and had started cash-and-carry raw milk business. Entire output, about 80–90 gal. daily, sold to customers at farm. Examn. of employees failed to discover any carriers of typhoid, but examn. of water supply cistern revealed organism *Eberthella typhosum*, present in considerable numbers. Examn. of cistern revealed that it had been adequately protected but had been filled several times from tank truck, source of water being city water supply. Apparently established that contamd. containers had been

washed in vat and that back-siphonage had contamd. water supply. As result of this outbreak and publicity which it received, no. of small dairies have started pasteurizing. Need of adequate regulation and supervision of dairies in unincorporated areas again demonstrated. Safeguarding water supply should not be limited to protecting source, but should include elimn. of possible cross-connections and back-siphonage.—*B.H.*

Preliminary Report on the Epidemic Outbreak of Typhoid Fever at Juana Diaz (November-December 1941). ABEL DE JUAN. Puerto Rico Health Bul. **6:** 57 (Mar. '42). In interval, Nov. 29 to Dec. 17, '41, 13 confirmed cases and 2 deaths from typhoid developed among the 3,931 urban inhabitants of Juana Diaz. All possible sources of infection elimd. except water supply. Supply taken from small impounded creek from which it flows, without treatment, to storage reservoirs and city. Bact. examns. of supply have usually shown high concns. of coliform organisms and municipality has consistently refused to adopt treatment as urged by health dept. Confirmed typhoid carrier found to be living near reservoir and working daily on watershed close to impoundment. Others with typhoid histories also employed in clearing operations on watershed few weeks before outbreak. No new cases occurred after emergency chlorination begun. 9,606 local residents vaccinated against typhoid fever at time of report. Recommended that supervision of supply be taken from munic. authorities and vested in the Insular Water Resources authorities as provided in Puerto Rican law.—*P.H.E.A.*

Typhoid and Paratyphoid Fever. BROWN. Lancet (Br.) **243:** 497 (Oct. 24, '42). Typhoid and paratyphoid fever became separately notifiable only toward end of '41. No. of cases notified in Eng. and Wales in past 5 yr: '37, 2,150; '38, 1,321; '39, 1,479; '40, 2,848; '41, 4,762. In '41, exceptional outbreak in Liverpool dist.—*Ralph E. Noble.*

Paratyphoid Fever: An Epidemiological Study. WILLIAM SAVAGE. J. Hyg. (Br.) **42:** 393 (July '42; issued Sept. 22, '42). Author studied 40 outbreaks in Great Britain, plus reports from America and elsewhere. Consideration confined to paratyphoid due to *Bact. paratyphosum* B [*Salmonella schottmuelleri*] usually present there. Epidemiologically, paratyphoid fever shows many differences from enteric fever. Incubation period decidedly variable and generally shorter; usually milder, but case mortality low in series studied, being more comparable to that in *Salmonella* food poisoning. Definitely prevalent in summer. Vector invariably food. Water- and shellfish-borne paratyphoid rare, whereas cream-borne most frequent. Assumed from evidence that paratyphoid bacillus less apt to invade body than typhoid, being dependent upon ingestion in considerable numbers. Water-borne infections effective only with mass inoculation and repeated consumption. Possibly preformed toxin involved. Chronic carrier source of infection rare compared with enteric fever. Transitory carriers, however, potential menace. Author impressed with extent to which *Bact. paratyphosum* B [*S. schottmuelleri*] true *Salmonella*, compared with behavior of typhoid bacillus.—*Ralph E. Noble.*

Natural History of Paratyphoid B. ANON. Lancet (Br.) **243:** 488 (Oct. 24, '42). Although an enteric fever, paratyphoid B differs materially from chief member of group. Savage stresses similarity to *Salmonella* [*cf.* previous abstract]. Closely associated bacteriologically, epidemiologically and to some extent clinically. Summer prevalence of outbreaks, 60% in May–July, closely approaches seasonal distr. of *Salmonella* food poisoning than to autumnal typhoid fever incidence. Paratyphoid and food-poisoning conveyed same way by infected food. In contrast with typhoid, water-borne outbreaks of paratyphoid fever rare. In Brixworth outbreak [*cf.* following abstract], however, small water supply heavily contamd. Paratyphoid bacilli readily recoverable from sewage and such effluents. Wilson and Blair found organism viable 21 days compared with 38 for typhoid. In 16 of 40 outbreaks anald. by Savage, cream infecting vehicle. Incidence of paratyphoid B fever among pop. low and intermittent, but much greater no. infected than become ill. Well recognized that paratyphoid fever, particularly in children, may produce diarrhea, vomiting and acute abdominal pains characteristic of acute food poisoning. Perhaps only symptoms, but commonly followed immediately or soon thereafter by typical enteric symptoms. Many older writings failed to distinguish between *Salmonella schottmuelleri* and other *Salmonellas*, particularly *Bact. typhi murium* (*B. aertrycke*). Savage postu-

lates common origin for these. In its evolution, paratyphoid bacillus acquired some invasiveness of typhoid bacillus while retaining some intestinal irritant properties of *Salmonella*. Other comparisons made.—*Ralph E. Noble.*

A Water-Borne Outbreak of Paratyphoid B Fever. D. J. Jones & P. G. H. Gell. Lancet (Br.) **243:** 363 (Sept. 26, '42). Paratyphoid fever outbreak at Brixworth, Eng., described. 21 of 34 residents infected in 7-cottage group built around court contg. pump from shallow well. From mode of onset and distr., outbreak believed water-borne. Confirmed by isolation of *Salmonella schottmuelleri* from 5 different samples of well water in 3 different labs. Method by which well infected not discovered, but ample opportunity in poln. of ground in vicinity.—*Ralph E. Noble.*

Immunization With T.A.B. in Outbreak of Paratyphoid Fever. E. Cunningham Dax & Doris M. Stone. Lancet (Br.) **243:** 422 (Oct. 10, '42). Paratyphoid fever outbreak in closed community of 80 persons with exceptional opportunities for cross-infection described. All contacts immunized with T.A.B. vaccine, followed by routine examn. of feces over several wk. No. of contacts excreting *Salmonella schottmuelleri* in feces without developing symptoms exceeded no. of clinical cases and formed potential reservoir for spreading infection. Immunization of patients after exposure to infection appeared without harmful effects and possibly factor in abrupt termination of outbreak. Carrier rate not appreciably influenced by immunization. —*Ralph E. Noble.*

Paratyphoid Carriers: The Infectivity of the Feces and the Failure of Chemotherapy With Sulfapyridine and Iodophthalein. H. D. Holt & H. D. Wright. J. Path. & Bact. **54:** 247 (Apr. '42). Evidence that intermittency of *Salmonella schottmuelleri* excretion by carriers less marked than supposed. Attempts to treat carriers of same with soluble iodophthalein and sulfapyridine completely unsuccessful.—*Ralph E. Noble.*

Fluorosis in England. *The Geological Aspect as a Guide to Prevention.* C. N. Bromehead. Lancet (Br.) **240:** 673 ('41). Investigation being made on relation between geology of certain districts in Eng. and incidence of fluorosis in these dists. In dists. in which fluorspar known to be present in underlying rock, few cases of fluorosis; this may be due to insolubility of fluorspar. Where deposits of apatite found, moderate mottling of teeth occurred. When sodium salts also present, underground water supplies may contain considerable amts. of fluoride due to solubility of sodium fluoride. Known affinity of fluorine for phosphate of lime suggested examn. of regions where clay formations, contg. fossil bones or phosphatic deposits, exist. Cases of fluorosis found at places situated on lower Greensand coprolite bed in Buckinghamshire and Bedfordshire; phosphatic nodules in bed known to contain as much as 2.8% fluorine. In localities on Oxford Clay, which may contain as much as 480 ppm. fluorine, high incidence of fluorosis and further investigations being made. Concluded that well water derived from or in contact with phosphatic beds or clays of marine origin may cause fluorosis. The consumption of such water should be avoided.—*W.P.R.*

Endemic Fluorosis in the Pretoria District. T. Ockerse. J. S.Afr. Med. **15:** 261 ('41). Endemic dental fluorosis occurs in many areas in S.Afr. Concns. of fluorine in drinking water vary from 0 to 36.67 ppm. Six cases of chronic fluorine intoxication occurring on farm in Springbok flats area of Pretoria dist. studied. Water for farm pumped from borehole 350′ deep, which passes down through formations of limestone, dolerite, shale and calcite. Source of fluorine may be fluorapatite in dolerite or detrital apatite. Anal. of water from borehole showed that it contained 11.78 ppm. fluorine. Teeth of children who had used water from borehole for drinking had mottled enamel. Mottled enamel also found on teeth of 4 cows reared on farm. Six natives who had used water from borehole since '22 showed symptoms which, from clinical and radiological examn., similar to those of chronic fluorine intoxication described by other investigators.—*W.P.R.*

Dental Fluorosis and Caries in London Children. Margaret M. Murray & Dagmar C. Wilson. Lancet (Br.) **242:** 98 (Jan. 24 '42). During examn. of evacuated London children for nutrition, observed that several exhibited mottling of teeth. Of 1400 children, 589 between ages of 10 and 15 yr. selected as showing all grades of mottled enamel. These reserved for special report

until results of anal. of samples of 3 main sources of London's water supply obtained. Connection between immunity to dental caries and fluorine recognized for last half-century, but only within last decade that discovery of fluorine as cause of mottled enamel proved, so that like putting cart before horse to say "importance of fluorine as trace element in animal nutrition hitherto overshadowed by clinically more arresting signs of fluorosis." From tables given would seem that severe mottling less protective than moderate, which stands at 0.4 carious teeth per child, while that for severe is 1. When no sign of mottling, avg. carious teeth per child 4.1. Anal. of samples of London water showed filtered Thames 0.1 ppm.; filtered Lee 0.15 ppm.; filtered New River 0.32 ppm. Figs. very low in fluorine content and below that of other endemic areas. Work proceeding on subject and further report will be welcomed, for in this, which is brief and condensed, no suggestion as to any examn. as to locality from which children came nor whether ascertained that they were born in locality or had passed sufficient no. of critical years in areas in which water supply showed appreciable amt. of fluorine.—*B.H.*

Dental Caries in Indian Children. K. L. Shourie. Indian J. Med. Res. **29**: 709 (Oct. '41). (1) Extent of dental caries in 6,866 children aged 6 to 18 in various parts of India studied. (2) Percentage free from caries recorded as 44.5, much higher percentage than that observed in Eng. and U.S. (3) Incidence of caries in deciduous teeth higher in girls than in boys. (4) Urban children in all age groups showed more caries than rural children. Wheat-eaters had slight advantage over rice-eaters. No correlation between income and extent of caries observed. (5) Highest incidence in permanent teeth observed in Anglo-Indian orphanage, where diet in many respects superior to that consumed by Indian children investigated, but included bread made from refined wheat flour and fairly large quants. of sugar.—*B.H.*

INDUSTRIAL WATER SUPPLY

Purer Water Supplies: Methods and Equipment. Anon. Chem. Metall. Eng. **48**: 6: 100 ('41). Discusses requirements of water for use in industry. In pulp and paper industry about 150,000 gal. of water needed to produce 1 ton pulp. At one mill producing 160 tons of pulp a day for rayon industry 30 mgd. water treated for removal of hydrogen sulfide and 9 mgd. completely softened. In mfr. of rayon by viscose process, between 80 and 100 gal. of water per lb. of rayon used. For sulfur-mining operations about 3,000 gal. of water required for production of 1 ton of sulfur; much of water used for melting mineral so that it can easily be brought to surface. Chem. compn. of water obtained from different sources and in different parts of America discussed. For mfr. of pulp and paper, water should contain <35 ppm. calcium carbonate to prevent formation of scale on deckers, screens, etc., and for high grade products, water should contain <10 ppm. suspended solids, and >10 ppm. color, 0.1 ppm. iron, 0.05 ppm. manganese, and 10 ppm. carbon dioxide; residual content of 0.3 ppm. chlorine should be maintd. to prevent growth of slime bacteria; if chloramines used, 0.8 ppm. residual chlorine should be maintd. In rayon industry, water should contain practically no hardness or turbidity and <0.1 ppm. iron and 0.05 ppm. manganese. Water for tanning leather should be free from appreciable hardness which stiffens leather and ppts. tannin; high causticity causes over-swelling and interferes with proper working of hide. Blending and rectifying water in distg. industry generally of same qual. as distd. water. Accts. included of methods of sedimentation (with and without coagulation), filtration, and softening by cold or hot lime-soda process and by hydrogen- or sodium-zeolite process; methods used to treat boiler feed water for removal of silica, dissolved gases, iron and manganese and to prevent corrosion and methods for removal of tastes and odors from water also discussed.—*W.P.R.*

Standardizing Paints for Industrial Piping. *Consolidated Report on Project No. 8.* K. J. Howe, *et al.* Official Digest Federation Paint & Varnish Clubs No. 212: 9 ('42). Project to develop standardized painting system for industrial piping for identification of materials carried. Pittsburgh Club recommended that fire-fighting equipment be painted red, gas lines yellow, water lines light blue and air lines light green. New York-New Jersey Club based their recommendations on co-operative

study ending in '28, suggesting following scheme: fire-protection equipment, red; dangerous material, yellow; safe products, green; protective materials, blue; extra-valuable materials, purple. Recommendations of both clubs regarding vehicles and pigments included—*C.A.*

Industrial Waters of Canada. *Report of Investigations, 1934 to 1940.* HARALD A. LEVERIN. Canadian Dept. of Mines and Resources, Publication No. 807 ('42) (*see also* Jour. A.W.W.A. **33**: 967, 1160 ('41). Complete anals. given of 217 samples of surface waters collected at key stations on large lakes and rivers of indus. importance, together with partial analyses of 583 samples taken from civic water supplies. Distr. of hard waters and no. of persons using water of different degrees of hardness shown in tables, maps and figures. [One of these is the diagram, Fig. 1, showing variations of total hardness of the waters of the Great Lakes basin.] In prepn. of hardness maps, on which is plotted, by symbols, range of total hardness for each place, centers of pop. of 3,000 and over in more densely populated eastern part of Canada and of 2,000 and over in rest of country selected, giving total of 237 supplies serving 300 communities and representing 52.4% of total pop. Weighted avg. hardnesses, obtained by adding products of avg. hardness of each supply and no. of persons served and dividing by total no. of consumers, given for ground, surface and all supplies serving above pop. groups in each province. Weighted avgs. so obtained for whole of Canada are: surface supplies, 97.8; ground waters, 343.8; all supplies, 118.0—expressed as $CaCO_3$. Included in report are outline of methods of anal. used, extended discussions of impurities in natural waters, their origin and effect on various industrial processes, and descriptions and discussions of methods employed for purif. of water.—*R. E. Thompson.*

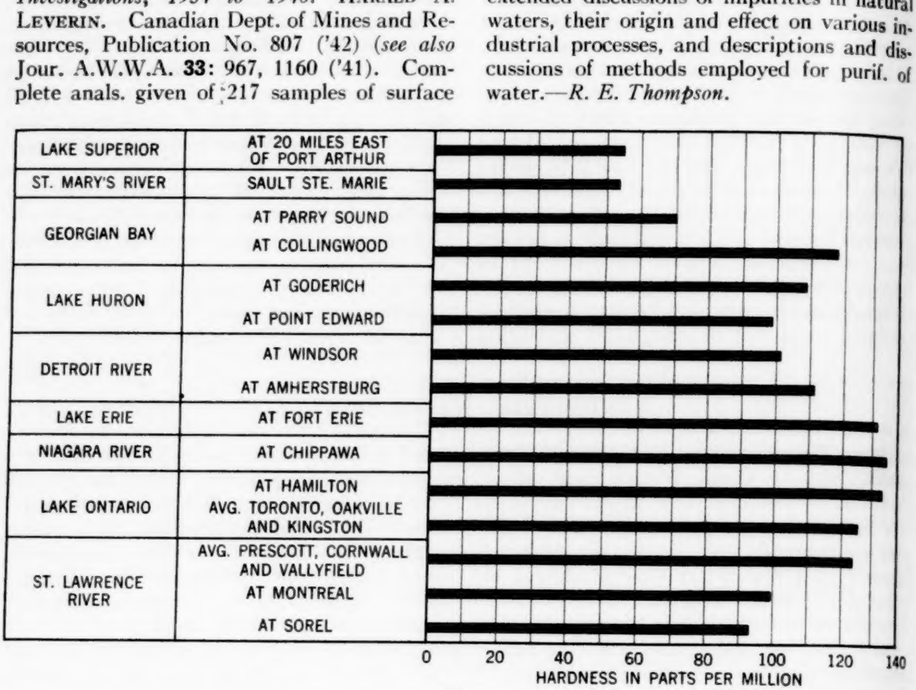

FIG. 1

Treatment and Sterilization of Air-Conditioning Water Supply. HARRY STEVENS. Proc. 15th Ann. Conf. Md.-Del. Wtr. & Sew. Assn. ('41). p. 4. Water from Tidal Basin, Dist. of Columbia, used for air-conditioning purposes by Fed. bldgs. at indicated 8,275 tons capac. Vol. of cooling required approx. 3¼ gal. per ton capac. per min., or about 20,000 gal. After plants put in operation, org. matter in condensing water clogged bldg. suction strainers to extent continuous cleaning necessary, insufficient cooling water pumped, and shut-downs frequent. At times, as much as 50% substitute water taken from D.C. mains. Offending organism was *pectinatella* with statoblasts. Found in shade on submerged branches or twigs, wooden stakes,

dam gates, reservoir walls, or stones in brooks. Appeared in strainers as gelatinous-like mass resembling frogs' eggs. Overpowering odor made handling and disposal extremely disagreeable. Chlorine injected into tunnel near intake at Tidal Basin through 1½″ rubber hose underground. At first, 2 ppm. fed continuously about 2 mo. Then rate gradually lowered to 2 ppm. for ½ hr. of every 3. Further reduced later on. This treatment proved org. matter had been developing in tunnel rather than in Tidal Basin as previously thought. Marked increase in eff. and labor saving resulted.—*Ralph E. Noble.*

Current Methods of Purifying Water for the Pulp and Paper Mill. A. F. McConnell. Paper Tr. J. **112:** TAPPI Sec.: 325 ('41). Characteristics which render water unsuitable for use in paper industry: turbidity, color, hardness, and presence of appreciable quants. of iron, manganese, and org. matter. Turbidity causes spots and decreases strength of paper. For fine paper up to 5 ppm. turbidity can be allowed and up to 50 ppm. for ground wood pulp. Turbidity removed by coagulation with alum, with or without settlement, and followed by passage through sand filters. Color caused by org. matter, iron, and manganese; should not exceed 5 ppm. and should be nearly zero for some products. Color can be removed by flocculation with alum if ratio of alky. to carbon dioxide in water adjusted to within narrow limits. Iron in water adsorbed on cellulose, causing discoloration of paper. Amt. which may be present without damaging paper varies with grade of paper, but should be below 0.2 ppm. By coagulation and filtration, possible to reduce content of iron to 0.05 ppm. Iron can be removed by settling and filtration with or without aeration or coagulation; treatment depends upon form in which iron present. Water softening by base-exchange removes soluble ferrous iron as well as hardness. Manganese causes discoloration of paper and may clog pipelines with black deposits of oxide. In presence of chlorine, used for bleaching, manganese oxidized to permanganates which give reddish color to the fibers. In water for high-grade products less than 0.05 ppm. should be present. Manganese difficult to remove as it is oxidized more slowly than iron, and requires longer period of retention in settling basins, and higher pH value; presence may inhibit oxidation and pptn. of iron. Methods of mixing and feeding chems. described. Description given of Spaulding precipitator in which can be carried out: coagulation and settling of turbid waters, removal of hardness, iron and manganese, and, under special conditions, removal of silica and fluorides by adsorption. Acct. given of constr., operation and washing of gravity and pressure sand filters. Feed water for boilers of paper mills may be treated by hot lime-soda process to remove oxygen and carbon dioxide and to soften water. Water then settled and passed through pressure filters contg. non-siliceous medium, such as anthrafilt or calcite. Carbonaceous zeolite particularly suitable for softening water low in silica. Carbonaceous zeolites also remove sodium, magnesium, calcium, iron, aluminum and manganese from soln., reduce alky. to any desired extent and remove bicarbonates from soln.—*W.P.R.*

Economic Losses Due to the Activities of Micro-organisms. J. R. Sanborn and R. A. Gillotte. Paper Tr. J. **112:** TAPPI Sec.: 253 ('41). Discusses adverse effect of micro-organisms on production of paper in pulp mills and methods of controlling harmful organisms. Bact. counts made at various stages in processing of paper, both during periods of excessive development of micro-organism and after preventive measures taken; results of anals. made at four mills shown in tables. List given of most commonly occurring micro-organisms; contains organisms which produce slime, destroy cellulose fiber, cause mildew in stock, rot felts, aggravate corrosion and produce odors. Special problems caused by presence of certain organisms which produce slime, including bacteria, yeast-like organisms and fungi, discussed; similar problems encountered in other industries. Nearly all paper and pulp mills add germicidal substances to process waters; satisfactory results obtained by adding 0.5 to 2.0 ppm. chlorine. White water for re-use in closed systems can be treated with chloramines or pentachlorophenates; addnl. treatment with copper sulfate sometimes necessary. Mills which obtain their stock from other mills may have to use measures for control of growths at various points in system.—*W.P.R.*

Fuel Economy From the Viewpoint of the Water Engineer. R. C. Bardwell. Bul. Am. Ry. Eng. Assn. **43:** 426: 20 (Oct. '41). Conditioning of 200 billion gal. of water used annually for steam purposes on Am. railroads involves not only testing water, providing necessary treating equip. and necessary chems.,

but actual operation in locomotive boilers must be checked and suitable blowdown schedules arranged to obtain max. eff.—*R. C. Bardwell.*

Water Service—Is It Keeping Pace. A. B. PIERCE. Ry. Eng. & Maint. **37**: 873 (Dec. '41). Modernization of railroad water service facilities to serve faster schedules now in operation required installation of greater capac. pumps, storage tanks and delivery lines at more important stations. Southern Ry. has retired 60 water stations during past few years, installed 80 automatic elec. stations replacing steam plants. On investment of $110,000 in 60 plants, annual saving of $78,000 being obtained. Qual. of water used by diesel units more important than for steam power.—*R. C. Bardwell.*

Welding in Water Service. J. P. HANLEY *et al.* Ry. Eng. & Maint. **37**: 810 (Nov. '41). One of outstanding developments in labor saving devices and methods of doing work in railway water service in recent years extended use of oxy-acetylene and electric-arc welding. Most repair gangs now furnished with portable oxy-acetylene welding and cutting equip. Welding saves time and reduces no. and type of fittings required. Cutting torch of particular advantage in removing old piping and equip. and in burning out old lead joints. Many welded steel storage tanks erected during past few years.—*R. C. Bardwell.*

Illinois Central Solves Emergency Created by Drought. ANON. Ry. Eng. & Maint. **37:** 609 (Sept. '41). Drought conditions which prevailed in southern Ill. for more than year, caused by deficiency in rainfall which only about 60% of normal over 18 mo., resulted in serious water shortage at Carbondale. Capac. of munic. reservoir was 400 mil.gal. with avg. daily consumption of 1 mgd. of which 0.5 mil.gal. used by Ill. Central R.R. In June '41, reservoir supply reduced to 4 mil.gal. and railroad forced to find other source of supply. By installing 8,100′ of 10″ and 12″ steel pipe, connections made to existing lines from emergency pumping plant installed on Big Muddy R. about 4½ mi. north of Carbondale. New station placed in service 10 days after authorization by using second-hand and reclaimed equip. which could be assembled rapidly. Plant to be kept in service until dependable supply developed by municipality. —*R. C. Bardwell.*

Practical Size of Water Columns and Supply Lines for Maximum Delivery to Locomotive Tenders. H. E. SILCOX *et al.* Bul. Am. Ry. Eng. Assn. **43**: 427: 99 (Nov. '41). To keep pace with faster train schedules, demands for water delivery to locomotives increased from former avg. of 1,500 gpm. to from 3,500–5,500 gpm. Delivery at water columns controlled by: (1) size, length and condition of supply pipeline; (2) flow head of storage tank above water column outlet; and (3) type and design of water column. Separate study of each location required for detg. necessary changes for best results, but increasing size of water column supply line appears most effective. Charts showing expected deliveries for std. 10″ and 12″ water columns used on 12″, 14″ and 16″ supply lines up to 8,000′ long, given.—*R. C. Bardwell.*

Hauls Water for 40 Cents per 1000 Gallons in Overcoming Serious Shortage. ANON. Ry. Eng. & Maint. **38:** 100 (Feb. '42). Failure of city water supply at Centralia, Ill., from which Ill. Central R.R. normally obtains requirements, compelled railroad to haul 450,000 gpd. to this terminal during Sept. and Oct. '41. City reservoir with normal capac. of 1,080 mil.gal. became so depleted by lack of rainfall in '40 and '41 that supply for railroads shut off late in Aug. '41. 100 and later 60 tank cars used by the Ill. Central to haul water 36 mi. from Duquoin to Centralia where it was dumped into small emergency reservoir and pumped to storage tanks. Daily work train required and estd. cost for hauling and repumping 40¢ per 1,000 gal. New city reservoir of 3,600 mil.gal. capac. expected to elim. trouble from droughts.—*R. C. Bardwell.*

Reducing Alkalinity by Means of Hydrogen Exchange. RALPH C. ADAMS. Brewers Digest **17: 6:** 40 (101T) ('42). Alky. of water used in beverage industry can be reduced by use of zeolite water softeners, which replace Na ions by H ions. Zeolite regenerated by treatment with dil. acid. If water contains chlorides or sulfates, corresponding acids produced causing treated water to have acidic reaction. Neutral or slightly alk. water obtained by mixing small proportion of untreated water with treated water.—*C.A.*

Purification of the Water Used in the Manufacture of Butter and in Dairies. C. VON DER HEIDE. Molkerei-Ztg. (Hildesheim, Ger.) **55:** 313 ('41). Tolerances with respect

to chem. compn. temp., odor and color given. Apparatus described for sterilization of water, and for simultaneous reduction of manganese and iron. Org. matter, sulfides, nitrites and ammonia also oxidized. Apparatus comprises chlorination and reaction tanks, pumps and filters for removal of (1) sediment and pptd. matter, (2) excess chlorine, (3) excess acidity and (4) organisms.—*C.A.*

Engineering Aspects of the Chlorination of Cooling Water. C. M. MERRILL. Proc. Inst. Food Technologists. ('41). p. 230. Potable water should be used for all operations involving contact of food with water or where food and water mixed. Use of approx. 1–2 ppm. free chlorine in cooling water in food canneries ensures water of satisfactory bact. qual. Even concns. of chlorine as high as 10 ppm. caused no injury or corrosion to tin plate.—*C.A.*

Combating Organic Fouling of Cooling-Water Circuits. F. J. MATTHEW. Petrol. Times **45**: 752 ('41). Addn. of 10–20 ppm. Na chlorophenate to water in cooling systems will give good control of slime and algae formation while inhibiting also growth of crenothrix and other iron bacteria. Compd. introduced in form of 1-oz. tablets placed in wire basket or bag. For cleaning out systems already fouled, concn. of 30 ppm. maintd. for about 10–15 days, then reduced in decrements of 5 ppm. until algae growth begins to reappear, finally increased by 5 ppm. and maintd. at that level. Algicidal action indicated by change in color of growth from greenish to brown and gray. Water should not be used for bathing or drinking.—*C.A.*

Condenser Scale and Algae Control. H. T. HOLBROOK. Ice & Refrig. **103**: 137 (Sept. '42). Scale and algae troubles closely linked, as latter important factor in scale formation beneath, preventing action by scale remover or inhibitor. As different mech. methods of scale removal costly and unsatisfactory, suitable chem. remover or inhibitor desirable. Softest scale largely Ca or Mg carbonates; harder ones also contain silicates and sulfates. Chem. removers of 2 classes: (1) those which penetrate, expand and lift scale in flakes; and (2) acid-type treatment, chem.-inhibited to prevent excess attack on metal, turns scale into soluble salts. Phosphates most popular and effective types of inhibitors in circulating water to keep scale-forming elements in soln. Act as buffer. As certain max. concn. not to be exceeded, essential in any scale-treatment work, especially with enclosed forced-draft towers and enclosed condensers, that sufficient blow-off or water renewal maintd. in circulating system. Treatment requires prelim. anal. to det. type of scale and which chem. needed. Unless scale soft, cheaper and quicker to use inhibited acid for enclosed condensers or some manual method of scale removal, then depend on chem. treatment for inhibition rather than expect quick results by ordinary scale treatments. In using inhibited acid, usual to circulate, at high veloc., 10% HCl soln. to water in system, soln. to contain proper amt. of commercial inhibitors. Important that veloc. be rapid and open pump available at some point in circuit to release carbonic acid gas, and to inspect for complete scale removal before resuming operation. With g-i. surfaces, better to use 5% soln. and longer removal time. Chromic acid inhibitor and chlorination for algae exptd. with. Different algae varieties require different treatments. Copper sulfate generally too corrosive. Chlorine as Ca or Na hypochlorite usually effective. As much as 150 ppm. used in condensers without damaging metal surfaces. Methylene blue appears effective and inexpensive algicide for many varieties. Sodium tetrachlorophenol found useful but not readily available on mkt. As algae forms change, often necessary to change treatment. Prelim. but intelligent trial and error tests necessary to det. effective agent in specific problems. Chem. application must be conscientiously followed by plant mgr. Definite records should be kept at all times to prevent repetition of erroneous expts. With experience, however, systematic and effective control procedure obtained.—*Ralph E. Noble.*

Tropical Plant Condensing Problems Uniquely Solved. JOHN T. FARMER. Elec. World **117**: 800 (Mar. 7, '42). Supply of cooling water for condensing taken from lagoon beside plant, in which only water change due to tidal ebb and flow. Temp. ranges from 81–86°F., limiting vacuum attainable. Difficulty experienced with shellfish growth on inside of intake pipe. Held in check to degree by intermittent chlorine injections, but certain amt. mech. removal necessary. To facilitate latter, individual pipe for unit laid out with "Doublex Simplex" sleeves at intervals to permit ready opening and cleaning of short lengths.—*Ralph E. Noble.*

BOILERS, FUEL AND FEED WATER

Increasing Capacity of Undersized Boilers. T. W. Reynolds. Heatg. & Ventg. **39:** 8: 22 (Aug. '42). Clean boiler water, flues, smoke pipes, chimney base at smoke-pipe connection; repair all leaks at boiler base, smoke-pipe and chimney, at joints, doors and pipe openings in boiler jacket; provide lower connection to chimney for smoke pipe from coal water heater, or separate flue for coal or gas water heater. Draft stabilizer keeps gases in boiler longer, increasing their work; checks flame where gas passages too direct to stack; cools off chimney dangerously hot. If set in tee at chimney connection, stabilizer affords convenient cleanout. Chimney draft often improved by trying out unused flue where available. Smaller sized flue may have good draft if higher, straighter, fewer air leaks than one in use. Det. by burning paper. Usually thin wall divides 2 adjacent flues. May develop interleaks impairing draft in one operating. Overcome and produce large flue effect by removing partition at top and bottom of chimney as far as reach. In coal-burning boiler, maintg. higher fuel bed often increases boiler output by increasing amt. of live coal contact with water backed heat absorbing surfaces. Effect greater in round boiler than sectional. Irrespective of type, however, 1 sq.ft. of surface so contacted equiv. in amt. of heat absorbed to many sq.ft. of surface elsewhere in boiler. Other advantages cited. Raising water line in boiler reduces steam space. Does provide added safety factor against water line becoming dangerously low. Also of some value in summer water heating. —*Ralph E. Noble.*

Coal Situation—Use of Coke and Coke Breeze for Steam Raising. Anon. Wtr. & Wtr. Eng. (Br.) **45:** 182 (Nov. '42). Situation may arise when certain kinds of coal not available. Generally, in case of hand-fired boilers, if max. load below rated output of boiler, coke alone can be used instead of coal. In case of coke breeze, experience indicates, with natural draft grates, it is advisable to mix it with coal or to install forced draft grates capable of consuming it alone or mixed with coal. Under natural draft conditions in hand-fired boilers max. combustion rate generally should not exceed 16 lb. per sq.ft. per hr. Main differences between firing coal and coke are that, with coke, a thicker fire bed can be carried with improved efficiency and with little or no secondary or over-fire air, and that greater radiant heating is generated because coke is high in carbon. Even though breeze alone, on a natural draft grate, may hold load, it is more satisfactory to mix it with small proportion of coal. Forced draft furnaces are able to consume breeze alone efficiently, satisfactorily and economically. Though low volatile fuel may be consumed efficiently on forced draft grate at about 35 lb. per sq.ft. per hr. and evaps. fuel at rate of about 9 lb. per lb. of fuel, corresponding rates with coke breeze alone are lower, *viz.* 25 lb. and 6.5 lb. evapn. Mech. firing in shell-type boilers may be of "sprinkler type" suitable for self-cleaning grate. Arrangements should be made for fuels to be mixed consistently in correct proportions at all times. In mixing, difference in bulk density should be borne in mind as equal volumes of breeze and coal are not equal weights.—*H. E. Babbitt.*

Fuel Economy. Making Best Use of Water Power. Anon. Wtr. & Wtr. Eng. (Br.) **45:** 98 (Sept. '42). In earlier times, value of water power appreciated. In rural districts, water wheels now often left unused. Full advantage not being taken of available water power. Full output of turbine or wheel can, in most cases, be fully absorbed through medium of induction alternator, which can be considered as induction motor, driven at about 6% above synchronous speed. It will adapt itself to overspeed conditions and, by connecting suitable condenser and providing saturation, machines become self-exciting and continue to generate even if bulk supply fails. In typical installation, main source of supply is from two 125 kva. steam-engine-driven alternators running in parallel to meet max. demand of about 180 kva. Standby supply capable of supplying up to 50 kva. when steam plant is shut down. One change-over switch feeds 20-kw. induction alternator driven by V-ropes from water turbine, and running at speed of approx. 1,050 rpm. Induction alternator used to run with either supply from which it receives its excitation. Condenser switched in with induction alternator to compensate for its lagging power factor.—*H. E. Babbitt.*

Pointers on How to Conserve Equipment. ANON. Heatg. & Ventg. **39:** 5: 30 (May '42). Emphasizes important points in proper care of various equipments to conserve them and obtain max. output throughout duration. Many recommendations under headings: c-i. boilers, steel boilers, safety and relief valves, expansion valves, steam traps, stokers, refrig. systems. Under instruments and controls, advise to: (1) put maint. and operation of all instruments in one man's charge; (2) check installations and, where necessary, change locations away from excessive heat, fumes or vibration, or to make more accessible to observer; (3) fasten loose tubing against permanent beams or posts to avoid damage, if near floor, fasten down or build housing over it; (4) place covers or hoods over instruments exposed to weather or moisture from water or steam hose; (5) instrument man, only, to change instrument location; (6) store charts from recording instruments in cool dry place, keeping charts in original pkgs., lying flat; (7) glass thermometers handled only by men aware of easy breakage possibilities; (8) if tube of metal enclosed glass thermometer dirty, carefully remove front frame and wipe tube and scale with damp cloth—use no gritty soap; and (9) hang up long-stem thermometers not in use.—*Ralph E. Noble.*

Boiler Water Treatment. L. R. NELSON. Natl. Engr. **46:** 628 (Oct. '42). To reduce chems. used for treatment, prevent fouling of softening equip., obtain satisfactory treatment plant results, first clarify or remove suspended matter from water. Natural pools or basins, elevated tanks with cone bottom used as settling chambers. Where flow fast, Fe or Al coagulants added to form floc and accelerate settling suspended matter. Gravity or pressure type filters used for removing some types of suspended matter, but first cost, including that of backwash equip., make plan unattractive. Scale formation in boiler drums and tubes prevented by external and internal treatment. Method chosen detd. by several factors and mineral anal. *External Treatment Methods:* (1) Lime or lime-soda ash particularly suited to waters high in CO_2 and bicarbonate hardness, although successfully used in those contg. SO_4, chloride and NO_3 hardness. At room temp., called "cold process"; at 200°, "hot process." Either will work on batch or continuous treatment system, although former seldom used in "hot process." Advantages: reduced amt. of total dissolved chem. left in softened water, permitting longer boiler operation with min. blowdown. Treatment cost low although initial expense of equip. may be higher than with other types. Process efficient on raw water feed of stable mineral content, but, with latter changing, close supervision required. Cold process reduces raw water original hardness to 40 or 50 ppm. while hot process reduces it as low as 15 to 25 ppm., both waters being suitable for boiler use. Coagulants sometimes added with lime-soda to give more rapid settling and to reduce Si content. (2) Zeolite softeners of 2 types: with base exchange or Na zeolite, Ca and Mg replaced by non-scale forming Na; with hydrogen zeolite, H replaces dissolved mineral in raw water to produce one comparable to distilled water, slightly acid. Sometimes combined types operated in parallel and effluents mixed to give optimum boiler water. Original zeolite capac. restored by regeneration. NaCl used for sodium; H_2SO_4 for hydrogen type zeolites. Both produce zero hardness, particularly suited to waters high in Ca and Mg bicarbonates as water produced contg. Na bicarbonate and carbonic acid break down inside boiler drum to form CO_2 and cause serious corrosion. Overcome by addnl. external treatment at increased cost. *Internal Treatment:* Internal treatment of feed water prevents scale formation within boiler drum and tubes by adding chems. to boiler feed water. Generally, where boiler water supply contains larger amts. of Ca and Mg, most satisfactory to partially soften by external treatment then finish with internal. Chems. injected at suction of feed pump or, commonly, direct to boiler drum. Chems. used: soda ash, caustic soda, sodium aluminate, sodium phosphates, tannins and starches. First two least expensive when used in boiler drums with less than 300 psi. pressure. Prevent scale by throwing out Ca and Mg as soft sludge removed by blowdown. Not used in h-p. boilers because decomposes at high temps. into caustic soda and CO_2 which dissolves boiler metal. Continual excess required to prevent scale formation. For higher boiler pressures, better results with phosphate. Costs more than soda ash but can use less without decompn. Tannins and starches, org. chems. of indefinite reaction with dissolved mineral but retain Ca and Mg in soln. and prevent scale. Often used with soda ash or phosphate internal treatment method.

Case cited. *Caustic Embrittlement:* Boiler plate cracking usually confined to boiler drum where steel pieces subjected to high mech. stress as in butt straps, around rivets and where tubes rolled in boiler drum. Some cases show water in contact with failed metal extremely high in caustic alky., although in others occurred at lower alky. in presence of soluble Si. Generally std. practice to maint. A.S.M.E. SO_4 to CO_3 ratios in boiler drums for water, using soda ash or caustic soda method. Sodium phosphate, chloride, aluminate and tannin reduced caustic embrittlement in lab. tests. Cases rare where phosphate internal treatment used. *Priming and Foaming:* Commonly caused by excessive boiler rating, oil in boiler water from oily condensate returns, high concn. of sodium salts in boiler drum. Reduced by sodium aluminate with Na_2SO_4 in boiler drum. *Corrosion:* In feed water piping, boiler tubes and drums, and in attack on metals in prime mover engines serious. Two types—general corrosion and localized pitting. Latter usually caused by dissolved O_2, CO_2 and NH_3. Best to keep them out. Removal by mech. de-aeration or boiling feed water in open heater. Follow by chem. treatment to give zero O_2. In boilers of pressures up to 600 psi., sodium sulfite reduces O_2 to SO_4. $Fe(OH)_2$ and other compds. used at all boiler pressures and power to remove O_2 complete, but form insoluble compds. increasing ts. in drum. Plant records important.—*Ralph E. Noble.*

Recent Trends in Boiler Water Treatment. E. M. Grime. Proc. Master Boilermakers Assn. ('41). p. 124. Water treatment on railroads developed from promiscuous addn. of soda ash or boiler compds. to present carefully controlled addn. of necessary chems. to neutralize scale and corrosion and maint. Na alky. of from 15 to 20% of dissolved solids. Water treatment started on Northern Pacific R.R. in '27. Life of flues extended from previous 18 mo. to 4-yr. Federal limit. Flues scrapped from pitting declined from previous 30% to below 7%. Org. material used in lime-soda or wayside treatment has proved advantageous and reduced foaming troubles on extended locomotive runs of 1,008 mi. from St. Paul, Minn., to Livingston, Mont. Automatic, supplemented by manual, blowing permits engine runs of 18,000 mi. for passenger engines, and 7,000 mi. for freight engines, between washouts.—*R. C. Bardwell.*

Boiler Feed Water and the Locomotive Engineer. J. F. S. Macdonald. The Engr. (Br.) **173:** 539 (June 26, '42). Defects to which impure feed water gives rise are: priming, corrosion, scale formation and caustic embrittlement. Carrying over particles of water with steam is called priming. It is caused by excessive concns. of dissolved and suspended solids in water. Boiler design is factor considerably influencing priming. To prevent priming, concn. of dissolved and suspended solids must be kept down. Change of boiler water does this to some extent. Blowdown is restricted form of water change. Continuous blowdown principle extensively adopted lately but hardly likely to be as effective as periodic blowdown. Scale-forming waters not as rule corrosive, though they may be if carbonates present. Essential that feed water be deaerated. Steel corrosion can be largely elimd. by maintg. caustic alky. of boiler water at 10–15% of sum of sodium chloride and sodium sulfate content (expressed as equivalent caustic soda). Marine practice of placing zinc blocks in boiler to divert corrosive attack not adopted in locomotive work to appreciable extent. Scale formation caused by hardness of water. First consideration in avoidance of scale is washing out. When chem. treatment not given, withdrawal of engines once, twice, or even three times between shoppings will be necessary for boiler cleaning. Softening of water by chem. plant extensively adopted. Generally done by lime-soda or base-exchange process. Failures due to caustic embrittlement take form of fine cracks in boiler plates at riveted joints and other fine grooves. For pressures between 150 and 250 psi. caustic embrittlement may be inhibited by maintg. ratio of sodium sulfate to total alky. of 2 : 1 in boiler water.—*H. E. Babbitt.*

Boiler Water Treatment in Sand-Lime Brick Plants. Woelke. Warme (Ger.) **63:** 87 ('40); Chem. Zentr. (Ger.) **I:** 3156 ('40). Condensate from hardening boilers of sand-lime brick plants represents extn. water high in salts. Residue on evapn. 241–1,537 ppm. It contains 7.5–100 ppm. Cl, 3.5–42 ppm. SiO_2, has hardness of 0.8–1.2°. Phenolphthalein alky. varies from 1.2 to 8.4, methyl orange alky. from 3.0 to 11.6. When used again as feed water, especially in combination with an oil-contg. injected condensate, causes formation of oil-contg. silicate boiler scale and results in swelling of boiler tubes.—*C.A.*

Several New Processes of Water Treatment in Steam Boiler Plants. J. Leick. Korr. u. Metallschutz (Ger.) **18:** 151 ('42). Treatment by exchange substances reviewed. Org. SiO_2-free compds., which are temp.-resistant and show high exch. eff., used. Metallic cations exchd. for H ions and CO_2 removed by special equip. For complete salt removal, anions exchd. for OH ions. Colloidally dissolved SiO_2 not removed by this method. This must be done, especially in h-p. boilers, by use of special absorption materials.—*C.A.*

Treating Boiler Feed Water Chemically. C. A. Harper *et al.* Proc. Master Boilermakers Assn. ('41). p. 116. Estd. that about half of 350 billion gal. of water used annually on Am. railroads being properly treated at present, removing 262,500,000 lb. of scaling matter with estd. saving of $33,125,000. Boiler defects caused by water have been reduced from 64 to 87% for last 10 yr. over previous decade. Maint. of proper ratio of alky. to dissolved solids recommended for scale and corrosion. Conductivity devices described for checking dissolved solids to control handling of blowdowns and prevention of foaming.—*R. C. Bardwell.*

Treatment of Boiler Feed Water by Carbonaceous Zeolite Softener. Nicholas Fodor. Eng. Jour. **24:** 435 (Sept. '41). Installation of new high speed turbine required provision of entirely clean steam, free from carryover and with not over 1,300 ppm. total solids in boiler water to be maintd. without excessive blowdowns. To meet requirements, consideration given to hot-lime-soda and carbonaceous zeolite softener using both sodium and hydrogen exchange for boiler water treatment. Latter method chosen as most economical to meet requirements to be maintd. in boiler of: total solids, 1,300 ppm.; trisodium phosphate, 86 ppm.; NaOH, 160 ppm.; and Na_2SO_4, 706 ppm. Softener consists of two elements, one working on sodium cycle with regeneration of zeolite with common salt, other working on hydrogen cycle with sulfuric acid being used for regeneration. Typical reactions for (a) softening and (b) regeneration for (1) sodium cycle and (2) hydrogen cycle may be given as: (1)(a) $CaSO_4 + Na_2Z = Na_2SO_4 + CaZ$ (Ca zeolite); (b) $CaZ + 2NaCl = Na_2Z + CaCl_2$; (2)(a) $Mg(HCO_3)_2 + H_2Z = MgZ + 2H_2CO_3$; (b) $MgZ + H_2SO_4 \rightarrow MgSO_4 + H_2Z$. In operation water divided, part put through one and remainder through other unit, effluents then mixed and aerated for CO_2 removal. Amt. put through each unit proportioned to give effluent of desired alky. (17 ppm. as Na_2CO_3), some of Na_2CO_3 formed being utilized to neutralize HCl and H_2SO_4 formed in hydrogen cycle. Lake Ontario water with: alky. of 100 ppm.; total solids, 175; total hardness, 100; Ca hardness, 79; Mg hardness, 21; pH 7.6, changed to treated water with: alky. of 17 ppm., total hardness, 3; total solids, 100; pH, 7.0 to 7.2, which, on being heated in a feed water heater, is raised to 8.2–8.3. Sodium hexametaphosphate and sodium sulfite added to take care of traces of residual hardness and oxygen. Blending of water from 2 units allows maint. of proper Na_2CO_3 alky. and Na_2SO_4 ratio without feeding Na_2SO_4. Equip. used to supply water for boiler with 90,000 lb. per hr. continuous output at 665 psi. pressure and temp. of 650°F.; max. make-up requirement 50,000 lb. water per hr. To supply 34,000 gal. Na_2Z and 46,000 gal. H_2Z softened water required 70 lb. of concd. H_2SO_4 and 120 lb. NaCl. Cost of reagents $1.305 for 80,000 gal. and $0.195 for wash water, total of 1.87¢ per 1,000 gal. (avg. mo. figure); if blowdown loss cost figured in, total 2.08¢ per 1,000 gal. Phosphate used brings final cost up to 2.93¢; estd. final total costs for this water, if treated by hot-lime-soda treatment would be 6.52¢ per 1,000 gal. Plant also arranged for coagulation and sedimentation when raw water turbid. Only difficulties encountered have been of mechanical nature, several copper alloy valves corroded and concrete storage tank gave off hardness to water stored. Valves to be replaced with another alloy, tank lined with rubber.—*Martin E. Flentje.*

Water Treatment in Large Power Stations. G. W. Hewson. Chem. & Ind. ('41). p. 764. Std. of purity of feed water for well-designed closed-feed system for boiler plant working at 600 psi. pressure is: O not exceeding 0.01 ml. O_2 per l.; elec. cond., not due to NH_3, not exceeding 1 micromho per ml. at 20°; pH value in absence of NH_3 7.3 to 7.5 at 20°. Pure makeup water usually obtained by distn. from evaporators which form part of heat cycle. Concn. of 30 ppm. Na_2CO_3 or more in evaporator body should prevent formation of scale. When evaporators badly designed or water available unsatisfactory may be necessary partially to soften water before it enters evaporator. Exchange process often better

than lime-soda, since problems of settlement or filtration and of afterpptn. do not arise. Corrosion of feed heaters and economizers may be severe if O dissolved in boiler feed water cannot be kept at low concn. In closed feed system better to keep control by sealing than by relying on de-aeration, which is not always effective at full load. Chem. methods used to avoid corrosion when phys. methods for controlling O concn. fail. NaOH addn. to feed water to pH value of 9.0 used. Sulfite used to absorb residual O, sometimes with 0.1 ppm. $CuSO_4$ as promoter. When scale-forming materials in const. concn., sodium metaphosphate may be added to insure pptn. as sludge and not as scale. Phosphates in various forms are valuable in controlling $CaSO_4$ scale, silicate scale and alky. Sulfate/alky. ratios maintd. for inhibition of caustic embrittlement.—*C.A.*

Water Problems in Small Power Plants. Everett P. Partridge and A. L. Soderberg. Blast Furnace & Steel Plant **30:** 664 (June '42). *Scale Prevention:* On typical mid-western water, high in Ca and bicarbonate ions, lime-soda softening reduces both dissolved solids in boiler water and CO_2 in steam at same time it ppts. outside boiler $CaCO_3$ sludge which would require removal by blowdown and mech. cleaning. Equip. of contemporary design makes good use of this sludge by holding water in contact for prolonged period to carry pptn. reaction close to completion. Even best softening does not, however, prevent $CaCO_3$ scale formation on hard-worked heat transfaces when water evapd. in boiler. By using second stage softening in which Na phosphate added, amt. of Ca ion left in feed water may be still further reduced by removal as Ca phosphate, but subsequent acid treatment desirable to prevent this substance accumulating between softener and boiler. Base-exch. using properly balanced H_2 and Na cycles accomplish same gen. results as lime-soda softening and can be operated to yield feed water contg. even lower residual concns. of Ca and Mg ions. Base-exch. on Na cycle alone, however, definitely disadvantageous on water high in bicarbonate as it leads to high blowdown to maint. reasonable dissolved solids content and, more specifically, of NaOH in boiler water, while also allowing most of CO_2 liberation in steam. Economic balance usually favors lime-soda softening for waters high in hardness, but base-exch. on combined H_2 and Na cycles for those low in hardness. In current emergency, important that hard-pressed boilers at pressures <200 psi. be kept operating by pptg. with Ca phosphate all Ca ions entering with feed water. Sludge accumulation minimized by org. dispersing agent, tannin, and continuous blowdown. In most cases, however, preferable to remove most Ca ions from feed water by primary softening, using phosphate within boiler to clean up those passing softener. Addnl. phases discussed are: prevention of steam blanketing, instability of boiler steel, phys. factors in oxidation of steel by water, chem. acceleration thereof and intergranular damage in boiler steel.—*Ralph E. Noble.*

Conditioning Feed Water for High-Pressure Boilers. Austin C. Dresher. Power Plant Eng. **46:** 9: 70 ('42). With pressures increasing up to or over 2,000 psi., cleanliness of heating surfaces and control of other feed-water troubles equally increased. Problems developing as result of presence of silica both in water and steam emphasized. Embrittlement control using inhibitors other than sulfate, i.e., phosphates, tannins and lignins, suggested. Embrittlement testing also described. Nature of different troubles that are made more active described in general way. *Ibid.* **46:** 10: 67 ('42). Discussion of methods of conditioning as employed in modern h-p. plants, including consideration of evaprs., hot-process softeners (with many types of treating agents used for removal of varying impurities from those normally present to silica and all less easily removable materials) and zeolite softeners. Pre- or post-treatment and use of carbonaceous zeolites in connection with complete removal of all sol. salts discussed.—*C.A.*

Boiler Compounds and Boiler Water Conditioning. Benjamin Levitt. Chem. Indus. **50:** 657 (May '42). Purpose of boiler-water conditioning to elim. scale-forming constituents, prevent corrosion, foaming and embrittlement of metal surfaces. Special formula required in every case because of many variables. Various water sources confer different deg. of alky. Water contg. 0 to 3 gpg. soft; 4 to 7, moderately hard; 7 to 12, hard; beyond, very hard. External treatment consists of pretreating raw water before reaching boiler. In cold and hot processes, water chemically treated to remove temporary and permanent hardness, and neutralize acidity. Scale-

forming impurities pptd. out or filtered. Lime, soda and coagulation treatment described. Quant. of lime needed calcd. from bicarbonates. Soda requirement detd. from amts. of Ca and Mg sulfates in raw water. $BaCO_3$ not generally recommended because poisonous for direct steam cooking, and expensive. Unless raw water excessively alk., soda ash necessary to neutralize acidity of chems. With sod. aluminate, formula should allow for its alky. Hot process may reduce residual hardness to 0.5–1.0 gpg.; cold, to 1.0–2.0, under good treatment. Internal treatment consists of adding chems. inside boiler to convert $MgSO_4$ and $CaSO_4$ to insoluble $Mg(OH)_2$ and $CaCO_3$. When soda ash used, $MgCO_3$ formed, further decompd. by action of soda ash, part of which hydrolized to caustic soda (NaOH) under high temp., converting $MgCO_3$ to $Mg(OH)_2$. Excess soda ash used to combine with CO_2 naturally present in water and that formed by bicarbonate decompn. Excess caustic soda for internal treatment may cause embrittlement. Sod. aluminate also commonly used in liq. form with soda ash or phosphates. Combines with dissolved silica to prevent silica scale. Phosphates most effective as boiler scale inhibitor. Sod. hexametaphosphate least alk. of phosphates; contains highest P_2O_5, therefore most efficient. Also prevents feed-line deposits. According to A.S.M.E. code, ratio soda alky. to sod. sulfate should be 1 : 1 for pressures to 150 lb.; 1 : 2, from 150 to 250; 1 : 3, over 250. Sometimes sod. sulfite or bisulfite added to maint. ratio and inhibit embrittlement. Corrossion due to dissolved O_2 in water may be almost entirely prevented mechanically by de-aerators and heaters. Sod. sulfite or ferrous salt used to elim. completely remaining O_2. Chromates, nitrates and acetates also inhibitors. Alginates said to produce liq. sludge and minimize foaming and priming by adsorption of cryst. ppts. Tannin extracts from cutch, quebracho, mangrove, etc., used to inhibit pipeline scale. Starch or colloidal graphite used to make scale flaky, less adherent. Boiler compds. include block or slug type, dry powder and semi-liq. or gel. Each has some special merit. Usually sold with service and "tailor-made" on basis of periodic samples from raw water used and from each boiler. Slug of compd. prepd. by mixing chems. with sufficient water to form paste, poured into mold, crystd. One most recent development in water purif., application of ion-exchange synthetic resins of amine formaldehyde and tannin or phenol formaldehyde types. By treating water first by cation-exchange resin in hydrogen cycle, then by anion-exchange resin, all dissolved salts may be removed, obtaining almost equiv. of distd. water. Resins prepd. stable to acid, neutral or alk. hot or cold solns. Capac. high and regeneration efficient.—*Ralph E. Noble.*

Use of Anti-Foam Compounds to Reduce Road Blowing. J. H. Davidson *et al.* Bul. Am. Ry. Eng. Assn. **43:** 427: 85 (Nov. '41). "Foaming" differs from "priming" in that it is not subject to mech. control by proper operation. Critical concn. of dissolved solids which cause foaming in locomotive boilers varies from 125 to 200 gpg., depending on design of boiler and type of work. Critical concn. can be raised 75 to 100% by proper use of anti-foam compd. contg. small amt. of emulsified castor oil. Expts. indicate that there may be other more effective materials which have not been commercially developed yet. Practice on most railroads to control concn. by systematic blowdown rather than with anti-foam.—*R. C. Bardwell.*

The Frothing and Carrying Over of Boiler Water. S. A. Durov. Zh. Prikl. Khim. (U.S.S.R.) **13:** 693 ('40). (*In English,* p. 718). Processes of foaming and priming in boilers and their causes investigated. Precipitates formed by crystallization when calcium in excess and in colloidal condition when magnesium in excess. Theory of Hall that structure of scale changed by action of soda true only when ratio of magnesium to calcium between 0.5 and 1.0. Foaming could be explained by formation of colloidal ppt. and by high ratio of magnesium to calcium. Ppt. which contains excess of basic magnesium carbonate can absorb about 37% of oil and can carry over water to condenser of locomotive. Systems inorg. salt-magnesium-calcium investigated for deg. of foaming of solns. while boiling at suddenly reduced pressure which caused water to be carried over to other parts of locomotive. Significance of magnesium-calcium ratio in phenomenon of foaming confirmed by results.—*W.P.R.*

Symposium on Problems and Practice in Determining Steam Purity by Conductivity Methods. Proc. A.S.T.M. **41:** 1261 ('41). *Introduction.* R. E. Hall: In testing for steam purity, elec. conductivity has generally replaced older procedures such as throttling

calorimeter. Accuracy, adaptability, rapidity and ease of automatically recording continuous results of former more closely meets requirements for testing than do less accurate indirect measurements of solids by latter. *The Sampling of Steam and Boiler Water.* A. R. Belyea and A. H. Moody: Modern steam boiler and turbine design involving extended steam temps. and pressures have imposed stricter requirements in sampling of steam as well as boiler water. Sample or samples should be representative and study of boiler may require that several sampling points be used to obtain desired data. Sampling lines should be thoroughly flushed prior to taking sample. Generally, material used for sampling line same as that used for sample container, provided contact time short. Cooling coil must be corrosion-resistant and of sufficient size to reduce necessary size of sample to temp. and pressure desired. *Discussion.* Max Hecht: Large size of modern steam generator and cross-section of steam offtake makes problem of obtaining representative sample difficult. Steam velocities through nozzle important and often sample should be collected from multiple points within steam drum as close to the offtakes as possible. Tubing size should not be too large nor so small that linear velocities exceed critical to produce dissolution of metal. *Experimental Methods of Determining Conductivity Corrections for Dissolved Gases in Steam Condensate.* S. F. Whirl and W. A. Lower: Basis for various advocated methods for correcting conductivity measurements on steam condensate for presence of interfering dissolved CO_2 or NH_3 has been applications of correction factors for analyzed CO_2 an NH_3 or removal of gases prior to conductivity measurement. Small error in anals. may produce major discrepancies in corrected results, particularly for NH_3. Freshly prepd. stds. for Nessler's method superior to permanent stds. "Free" CO_2 detn. especially questionable below 1 ppm. Authors distil NH_3, CO_2, H_2S and SO_2 from sample which has been made successively alk. and acid into relatively pure water, and measure conductivity. Subtraction of blank detn. gives single correction omitting necessity for separate anals. Ammonia-free and CO_2-free water prepd. by redistg. distd. water treated with P_2O_5 and passing purified CO_2-free air through liquor in distn. flask. Distillate of consistently low conductivity (0.1 to 0.2 micromho). In procedure, vol. of distillate in which conductivity of dissolved gases measured, always same as that of sample. Conductivity corrections always less than calcd. correction based on separate factors for NH_3 and CO_2. *Calculation of Corrections to Conductivity Measurements for Dissolved Gases.* D. S. McKinney: Conductivity of condensed steam can be corrected when anal. of steam available. To interpret conductivity measurements in terms of non-volatile salts or percentage carry-over from boiler water, true conductivity, volatile substances such as CO_2 and NH_3, and non-volatile weak electrolytes, such as phosphates and carbonates, must be known. Data tabulated on ionic equivalent conductance and distr. of ions of weak electrolyte as function of pH. Sample calcns. given. *Joint Discussion.* E. P. Partridge: Whirl and Lower have assumed that NH_3 and CO_2 correction as measured in distillate identical with increment in conductivity as produced by these gases in actual steam condensate. In most cases this assumption produces negligible error, but emphasis given to fact that magnitude of effect of NH_3 and CO_2 dependent on pH. Correction curves indicated for various NH_3 and CO_2 concns. for various pH values from original curves by Watson (Trans. A.S.M.E. **62**: 732 ('40)). Simplified procedure for corrections indicated, which should be adequate for most studies in power plants. *The Degasification of Steam Samples for Conductivity Tests.* P. B. Place: (*Abstracted*, Jour. A.W.W.A. **34**: 312 ('42).) *A New Type of Conductivity Apparatus for Use With Boiler Waters and Steam Samples.* A. R. Mumford. Apparatus designed for full steam pressure and temps. and steam sample condensed in contact with vapor phase and with slight venting. Water samples degasified by flashing and venting vapor phase. CO_2 and NH_3 reduced to negligible amt. Conductivity measurements made in condensed water in apparatus at elevated temps. Hydroxyl correction thereby reduced to negligible amt. Complete report on performance postponed to future meeting. *Conductivity Cells and Electrical Measuring Instruments.* C. E. Kaufman. Conductivity equip. should be selected to obtain accuracy desired for interpretation by operator whose judgment based on practical experience. For precision, conductivity cell should be calibrated with KCl soln., whose conductivity is near that of unknown solns. to be measured. Elec. contacts should be solid and temp. of soln. should be known. Continuous flow cell chambers should be small to avoid lags in

reading. Electrodes may be of platinized platinum, smooth platinum, gold, stainless steel, or monel metal. Platinized platinum reduces polarization error. A-c. at 1,000 to 60, or if necessary 25, cycles should be used and measured by Wheatstone bridge (null point balance) which is inherently more stable and accurate, by current meter (deflection instruments) or by glow lamp arrangement. Judgment of operator of experience greatly enhances value of instrument. Same apparatus may be used to good advantage on raw feed water, but for boiler water concentrate offers difficulties even on diln. Unionized material such as tannin, lignin or other organic matter and silica not detected. *Joint Discussion.* R. T. Hanlon. Comparison of simultaneous conductivity detns. at high temp. and at 25°C. showed proportional increase and decrease for both cells. Too much emphasis cannot be stressed on calibration of cells for conductivity measurements. 75 refs. —*T. E. Larson.*

The Removal of Dissolved Gases From Boiler Feed Water. Arthur E. Kittredge. Blast Furnace & Steel Pl. **29:** 1130, 1225 (Nov., Dec. '41). Removal of dissolved gases from boiler feed water involves 2 phases. Extent of first controlled primarily by surface tension of liq. and pressure to which system subjected. Extent of second controlled by individual tray eff., no. of tray layers, and water viscosity as fixed by operation temp. In equip. for de-aeration involving spraying or atomization, de-aeration process similarly divided into 2 phases. As in tray de-aerator, one phase occurs largely in preheating chamber, other largely in spraying or atomizing chamber. Extent of first controlled by water surface tension and pressure in system. Extent of second influenced by water viscosity as functioned by operating temp. Unit of measure for detg. comparative results is energy utilized per lb. of de-aerator effluent at atomizing valve. High-tray racks more eff. than shallow. Regarding oxygen removal, direction of steam flow through or across tray stack inconsequential except as adversely affecting water distr. on tray. In spray or atomizing de-aerators, means should be provided to maint. const. pressure drop across atomizing valve. Complete removal of CO_2 or ammonia from water supply otherwise neutral, difficult due to high deg. ionization of small quants. of these gases in soln.—*Ralph E. Noble.*

Oxygen Control in Boiler Water With the Use of Sodium Bisulfite. Otto Michaelis. Wärme (Ger.) **63:** 12 ('40). When $NaHSO_3$ added to feed water, presence of O_2 can be detected from color of Mn ppt. and its HCl soln. Excess bisulfite can be detd. by titration with I soln. 0.01 *N* thiosulfate best standardized against 0.01 *N* $KMnO_4$.—*C.A.*

Note on the Analysis of Sulfite-Treated Boiler Water. W. M. Hague. Chem. Analyst **31:** 57 (Aug. '42). Excess Na_2SO_3 used for removing D.O. from boiler water causes noticeable errors in routine detns. of alky. and of chloride by $AgNO_3$ titration. Addn. of small amt. of neutralized H_2O_2 soln., approx. 15%, corrects these errors, excess H_2O_2 causing no difficulties.—*R. E. Thompson.*

The Application of Organic Amines to Steam Systems. M. E. Dreyfus. Heatg. & Ventg. **39:** 6: 31 (June '42). Patented process consists of introducing org. amines of certain phys. and chem. properties, into any part of steam system. Amines used, soluble in water, of alk. reaction and sufficiently volatile to vaporize and condense with steam, appearing in soln. in condensate in all numerous and distant zones. Condensate becomes alk. with pH, detd. by concn. and character of amine used. Amine function to neutralize acidity and raise pH of condensate to retard corrosion in presence of O_2. [Excellent discussion of elementary chem. of corrosion. No theory advanced to explain amine action of rust removal but latter reported too frequently to be disregarded.] Partial benefits resulting, therefore, include cleaning and restoring traps to eff. operation; elimn. of pipe clogging by rust deposits; rendering sluggish radiators more active; and improvement in steam circulation.—*Ralph E. Noble.*

Determination of Tannin Substances in Boiler Waters. A. A. Berk and W. C. Schroeder. Ind. Eng. Chem.—Anal. Ed. **14:** 456 (June '42). Increased use of tannin substances in boiler feed water treatment makes their detn. in water important. Method described uses reagent originally developed for tyrosine by Folin and Denis, and made by dissolving 100 g. of Na tungstate, 20 g. of phosphomolybdic acid and 50 ml. of 85% phosphoric acid in 750 ml. of water. Boiled under reflux for 2 hr., cooled and made up to 1 l. Comparison soln. contains 50 ppm. of solid or liq. extract being used to treat

boiler feed. Master std. soln. contains 25 ppm. of cp. tannic acid. For colorimetric detn. using Nessler tubes, 50 ml. filtered, clear, cooled sample contg. less than 3 ppm. of tannin or 20 ppm. of lignin measured into 100-ml. Nessler tube. Two or three similar samples made up from comparison soln. to contain greater and lesser amts. of tannin than sample, and made up to 50 ml. with distd. water. Samples and stds. treated with 2 ml. of tyrosine reagent, stirred, allowed to stand 5 min., 10 ml. of satd. sodium carbonate soln. added, stirred, and allowed to stand 10 min., before comparison of colors. Method also adapted to photoelec. cell colorimetry. Time not critical, though readings somewhat higher if tyrosine reagent reacts for 12 min. before Na_2CO_3 added, and time for readings, after addn. of Na_2CO_3, when once decided on, should be adhered to. Small temp. variations have no serious effect but large ones must be avoided or corrected for. Too high alky. may interfere, but may be compensated for by addn. of 1 drop of 1-to-5 H_2SO_4 for every 25 ml. of alk. boiler water tested. Most inorg. constituents of boiler waters do not interfere, though ferrous iron does. Usually too low in alk. boiler waters to cause difficulties however. Phenolic compds. will interfere, and blank should be run if presence suspected. Sample should be tested when fresh if possible; if it must stand, add 1 ml. of concd. HCl per l. per 300 ppm. of caustic alky.; then shake thoroughly before withdrawing portion for test. Tyrosine test dets. tannins and lignins as group and does not distinguish between them. Results by method given can be correlated in some deg. with quant. of tannin fed and with exptl. detn. of effect in boiler water.—*Selma Gottlieb.*

Effect of Container on Soluble Silica Content of Water Supplies. C. A. Noll and J. J. Maguire. Ind. Eng. Chem.—Anal. Ed. **14**: 569 (July '42). If silica to be estd. in feed and boiler waters, not safe to assume that increase in silica from glass container will be negligible, since appreciable increase may result. Containers used must not impart silica to sample and must not rust (e.g., steel drums or tin-lined cans) thus reducing silica content due to adsorption of silica on pptd. $Fe(OH)_3$. Hard rubber bottles and resin-lined cans excellent for sampling and storage of water samples. Recommended is std. resin-lined beer pkg. mfrd. by American Can Co.—*Selma Gottlieb.*

War Production Board Regulations for Laboratory Equipment and Materials

Orders L-144, P-43 and P-135

In the past few months, four major changes have been made by the War Production Board in the requirements for obtaining laboratory equipment and materials. All of these changes are of particular interest to water works men both in the field of public supply and in those industries where water quality is an important factor in operation, inasmuch as they affect the availability of equipment and materials required in their laboratory and control operations. To bring the record of WPB requirements up to date, a discussion of the current status of the various requirements, together with the texts of the applicable orders, is presented here.

The various changes mentioned above include: (1) revision of Limitation Order L-144; (2) revision of Preference Rating Order P-43 to include production control laboratories, to assign a better priority rating and to impose new restrictions; (3) issuance of a new order, Preference Rating Order P-135, covering reagent chemicals; and (4) revocation of the complicated Allocation Classification System which required the placing of classification symbols and numbers on each order.

Laboratories should not confuse the requirements and purpose of Limitation Order L-144 with Preference Rating Orders P-43 for apparatus and chemicals or P-135 for chemicals only. Limitation Order L-144 gives the laboratory the *permission* to buy, while the Preference Orders P-43 and P-135 authorize priority ratings applicable to obtaining the materials.

The new Limitation Order L-144 permits laboratories to purchase (without special permission) their entire requirements which do not incorporate scarce materials, also to purchase any article or a quantity of a particular article (on a single order) that has a value not exceeding $50 when these articles do have scarce materials incorporated in them. The $50 limitation does not apply to the total value of the order. Articles incorporating scarce materials and costing more than $50 are procured by obtaining special permission.

The man responsible for the operation of the laboratory should not procure any apparatus that is not needed at this time, but he should not allow the formalities to deter him from obtaining the laboratory materials necessary to maintain production. He should comply with the rules and order well in advance of his needs.

Order L-144 Revised

It is necessary for each laboratory to be familiar with the amended Limitation Order L-144 and its requirements,

and to comply with it. When the laboratory equipment ordered incorporates any of the scarce materials, the certification that this equipment is to be used in conformity with Order L-144 must accompany each purchase order. This L-144 certification is not required to purchase any desired quantity of articles such as glassware, porcelain, filter paper or other items in which the designated scarce materials are not incorporated.

Order L-144 remains unchanged in the uses to which the equipment may be put. Any laboratory may obtain its needed equipment and supplies when the laboratory does any of the following:

1. Conducts research on, or produces, analyzes or tests materials
2. Conducts research for U.S. and Lend-Lease war agencies
3. Trains personnel for U.S. and Lend-Lease war agencies
4. Requires replacements in public health and government laboratories
5. Requires materials to repair essential equipment
6. Is determined to be necessary in the public interest by the WPB pursuant to application on Form PD-620.

The new restriction which has been added to Order L-144 prohibits the laboratory from making the required certification for any item or quantity of the same item having a value of $50 or more, except when such certification has been specifically authorized pursuant to application on Form PD-620. The $50 limitation does not apply to the purchases of glassware, porcelain, filter paper or other articles which do not incorporate scarce materials, nor to reagent chemicals, because the purchase of such equipment and supplies requires no certification at all.

When the laboratory desires to purchase an article or (on a single order) a quantity of a particular article having a value greater than $50, and the article, or articles, incorporate scarce materials, permission must be first obtained by applying on Form PD-620, to the Safety and Technical Equipment Branch, War Production Board, Washington, D.C.

Order P-43 Revised

Preference rating order P-43, which formerly could be used only by research laboratories, has been revised to permit production control laboratories to qualify and be granted serial numbers. The revised order assigns a rating of AA-2X to qualified serial numbered laboratories for the purchase of any material (including reagent chemicals) except for the construction of laboratory buildings or other structures. However, when the value of any item or quantity of the same item of material exceeds $50, the rating may not be used unless the purchase is specifically authorized by the Director General for Operations pursuant to application on Form PD-620. Specific authorization is not required for the purchase of any reagent chemicals irrespective of whether the value is less than, or exceeds, $50.

The revised order also assigns a rating of AA-4 for the purchase of any laboratory equipment which is authorized by the Director General for Operations under paragraph (b)(2)(vi) of Limitation Order L-144, pursuant to application on Form PD-620.

Monthly reports are required on Form PD-93 by the fifteenth of each month, showing applications of the rating for delivery of material other than reagent chemicals, during the pre-

ceding calendar month. If no purchases of material were made, the monthly report must be filed nevertheless, with a notation to the effect that the rating was not applied during the month. No serial numbered laboratory may apply a preference rating under this order while in default for any monthly report.

Order P-135

The new order P-135 will supplement P-43, but only so far as reagent chemicals are concerned. It does *not* cover equipment. It will be noted that this Order P-135 covers a considerably broader field with respect to reagent chemicals than does P-43. P-135 assigns AA-2X for deliveries of reagent chemicals for use by *any* laboratory for analytical, testing, control, educational or research purposes, without the need of an application to, or approval by, the WPB. The rating may be used for purchase of reagent chemicals by any supply house for resale to laboratories for such purposes. The AA-2X may also be applied by the manufacturer of reagent chemicals for the purchase of production materials for the manufacture of reagent chemicals.

The preference rating assigned by P-135 may not be applied to obtain deliveries of any material which will be used in the manufacture of products for sale other than reagent chemicals, or in rendering of any service other than for the above specified purposes. The order also imposes a flexible limitation on the dollar value to which the AA-2X may be applied during any calendar quarter. This is a limitation on the extent to which the rating may be applied. It is not necessarily a limitation on the total volume of purchases.

Application and Extension

In applying or extending a rating under either of these orders, the purchase order should be endorsed as follows, in accordance with Priorities Regulation No. 3, as amended October 3, 1942:

Endorsement

The undersigned purchaser hereby represents to the seller and to the War Production Board that he is entitled to apply or extend the preference ratings indicated opposite the items shown on this purchase order, and that such application or extension is in accordance with Priorities Regulation No. 3 as amended, with the terms of which the undersigned is familiar.

....	....
(Name of Purchaser and PRP Certificate No. if Purchaser is a PRP Unit)	(Address)
By......................	....
(Signature and Title of Duly Authorized Officer)	(Date)

This Priorities Regulation cancels all previous forms of endorsement of purchase orders. Thus under P-43 no information copy of the order need be served on the supplier.

P-135, the reagent chemical order, will be administered for the present by Dr. David L. Watson in the Chemicals Branch. P-43, covering as it does equipment, will continue to be administered by W. R. Turner in the Health, Safety and Technical Supplies Branch.

Regulation No. 10 Revoked

The Allocation Classification Symbol formerly required by Priorities Regulation No. 10 has been revoked by the WPB (*see* Jour. A.W.W.A., **34**: 1923 (1942)). It will therefore no longer be necessary for laboratories to include the symbols on the purchase order, thus greatly simplifying procurement procedure.

Part 1261

GENERAL LIMITATION ORDER L-144 AS AMENDED AUGUST AND DECEMBER 1942

The fulfillment of requirements for the defense of the United States has created shortages in the supplies of Laboratory Equipment and the materials entering into the manufacture thereof for the war effort, for private account, and for export; and the following Order is deemed necessary and appropriate in the public interest and to promote the national defense:

1261.1 General Limitation Order L-144

(a) *Definition.* For the purpose of this Order:

"Laboratory Equipment" means material, instruments, appliances, devices, parts thereof, tools and operating supplies for laboratories, or for use in connection with operations usually carried on in laboratories, not including second-hand items. The term does not include reagent chemicals which are defined as any chemical prepared and packed for reagent use in laboratories.

(b) *General Restrictions.*

1. No person shall sell, deliver, rent, purchase, acquire or accept delivery of Laboratory Equipment in which there is incorporated or used aluminum, chromium, copper, iron, magnesium, molybdenum, nickel, steel tantalum tin, titanium, any alloy of said metal, rubber, neoprene or other synthetic rubber, or non-cellulose base synthetic plastics, except: (i) pursuant to a purchase order or contract having certified thereon a statement in the following form, signed manually, or as provided in Priorities Regulation No. 7, by an official duly authorized for such purpose:

Certification

The Laboratory Equipment herein ordered will be used or sold in conformity with the provisions of General Limitation Order No. L-144, with the terms of which the undersigned is familiar.

Name ....

By ....

(Signature of duly authorized official)

or (ii) pursuant to a purchase order or contract from the Army or Navy of the United States, the United States Maritime Commission, the War Shipping Administration, the Coast and Geodetic Survey, the Civil Aeronautics Administration, the National Advisory Committee for Aeronautics, the Office of Scientific Research and Development, or the government of any of the following countries: Belgium, China, Czechoslovakia, Free France, Greece, Iceland, Netherlands, Norway, Poland, Russia, Turkey, United Kingdom, including its Dominions, Crown Colonies and Protectorates, and Yugoslavia.

2. No person shall make the certification described in the foregoing paragraph for the acquisition of any item or quantity of the same item of laboratory equipment having a value of $50.00 or more, except for resale, or when authorized by the Director General for Operations under Paragraph (b)(2)(vi) of this Order pursuant to application on form PD-620; nor shall any person make said certification for acquisition of any laboratory equipment except for resale or use for one or more of the following purposes:

(i) Research on, or production, analysis or testing of, materials.

(ii) Research by or for the United States Army, Navy, Maritime Commission, or any other department or agency of the government of the United States, or of any foreign country entitled to deliveries under the Act of Congress of March 11, 1941, "An Act to Promote the Defense of the United States" (Lend-Lease Act).

(iii) Training of personnel for the United States Army, Navy, Maritime Commission, or any other department of the United States, or for the government of any foreign country entitled to deliveries under the Act of Congress of March 11, 1941, "An Act to Promote the Defense of the United States" (Lend-Lease Act).

(iv) To the extent necessary for the replacement of essential existing equipment in laboratories affecting the public health, and in United States government, state, county and municipal laboratories.

(v) To the extent necessary for repair parts and operating supplies for the maintenance of existing essential equipment and activities in laboratories.

(vi) For any use which the Director of Industry Operations, War Production Board, determines is necessary and appropriate in the public interest.

3. Said Certification shall constitute a representation to the War Production Board and to the person with whom the purchase order or contract is placed, that the subject matter of the order or contract will be used or sold in accordance with the provisions of this Order. Every person concerned shall be entitled to rely on said Certification, unless he knows or has reason to believe it to be false.

4. No manufacturer shall use any scarce material described in foregoing paragraph (b)(1), where and to the extent that the use of other material is practicable.

(c) *Applicability of Priorities Regulation No. 1.* This Order and all transactions affected thereby are subject to the provisions of Priorities Regulation No. 1 as amended from time to time, except to the extent that any provisions hereof may be inconsistent therewith, in which case the provisions of this Order shall govern.

(d) *Records.* All persons to whom this Order applies shall keep and preserve for not less than two years, accurate and complete records concerning inventories, production and sales, including copies of each purchase order or contract containing the certification hereinabove referred to.

(e) *Audit and Inspection.* All records required to be kept by this Order shall, upon request, be submitted to audit and inspection by duly authorized representatives of the War Production Board.

(f) *Reports.* All persons affected by this Order shall execute and file with the War Production Board such reports and questionnaires as said Board shall from time to time request.

(g) *Violations.* Any person who wilfully violates any provision of this Order, or who, in connection with this Order, wilfully conceals a material fact or furnishes false information to any department or agency of the United States is guilty of a crime, and upon conviction, may be punished by fine or imprisonment. In addition, any such person may be prohibited from making or obtaining further deliveries of, or from processing or using, material under priority control and may be deprived of priorities assistance.

(h) *Appeals.* Any person affected by this Order who considers that com-

pliance herewith would work an exceptional and unreasonable hardship upon him, may appeal to the War Production Board setting forth pertinent facts and the reasons such person considers that he is entitled to relief. The Director of Industry Operations may thereupon take such action as he deems appropriate.

(i) *Communications.* All reports required to be filed hereunder, or communications concerning this Order, shall, unless otherwise directed be addressed to:

War Production Board, Safety and Technical Equipment Branch, Washington, D.C. Ref: L-144

Issued this 12th day of June 1942.

Research, Production Control and Other Laboratories

PREFERENCE RATING ORDER P-43, AS REVISED NOVEMBER 5, 1942

To facilitate the acquisition of materials by research, production control and other laboratories, in the public interest and to promote the war effort, preference ratings are hereby assigned to deliveries to research, production control and other laboratories, upon the following terms:

Preference Rating Order P-43

(a) *Definitions.* (1) "Laboratory" means a research or production control laboratory approved and assigned a serial number by the Director General for Operations, or his predecessors, as a qualified laboratory, and whose serial number has not been suspended or revoked; and also any laboratory to the extent of its acquisition of laboratory equipment pursuant to application on Form PD-620 and authorization by the Director General for Operations under paragraph (b)(2)(vi) of Limitation Order L-144.

(2) "Material" means any commodity, equipment, accessory, part, assembly or product of any kind, except for the construction of laboratory buildings or other structures.

(3) "Laboratory equipment" means material, instruments appliances, devices, parts thereof, tools and operating supplies for laboratories, or for use in connection with operations usually carried on in laboratories, not including second-hand items. The term does not include reagent chemicals which are defined as any chemicals prepared and packed for reagent use in laboratories.

(b) *Assignment of Preference Rating.* (1) Qualified Serial Numbered Laboratories: Subject to the terms of this order, preference rating AA-2X is hereby assigned to laboratories:

(i) For deliveries of material for research or production control, provided that the value of any item or quantity of the same item shall not exceed fifty ($50.00) dollars.

(ii) For deliveries of material for research or production control when the value of any item or quantity of the same item exceeds fifty ($50.00) dollars, and such deliveries shall have been specifically authorized by the Director General for Operations pursuant to application on Form PD-620, except that specific authorization on Form PD-620 shall not be required for the purchase of any reagent chemicals.

(2) Other Laboratories: Subject to the terms of this order, preference rating AA-4 is hereby assigned:

To deliveries of laboratory equip-

ment to a laboratory not assigned a rating by paragraph (b)(1), when the delivery is authorized by the Director General for Operations under paragraph (b)(2)(vi) of Limitation Order L-144, pursuant to application on Form PD-620.

(c) *Restrictions on Use of Rating.* No laboratory may apply a preference rating assigned by paragraph (b)(1) while in default for the filing of any monthly report required by paragraph (e) of this order.

(d) *Application and Extension of Ratings.* Preference ratings assigned by or pursuant to this order shall be applied and extended in accordance with the terms of Priorities Regulation No. 3, as amended from time to time.

(e) *Reports.* Every laboratory which is assigned a preference rating by paragraph (b)(1) of this order shall file monthly reports on Form PD-93 on or before the 15th day of each month, showing applications of such rating for deliveries of material other than reagent chemicals during the preceding calendar month, or that the rating was not applied if such be the case.

(f) *Revocation or Amendment.* This order may be revoked, suspended or amended at any time, either generally or as to any laboratory or supplier. In the event of revocation or suspension deliveries already rated pursuant to this order shall be completed in accordance with the rating assigned, unless the rating has been specifically revoked.

(g) *Qualification of Research and Production Control Laboratories.* Any research, or production control laboratory not qualified and assigned a serial number by the Director General for Operations, or his predecessors, prior to the date of this order may apply on Form PD-107 for qualification and the assignment of a serial number.

(h) *Communications.* All reports required to be filed hereunder and all communications concerning this order, unless otherwise directed, shall be addressed to: War Production Board, Health, Safety and Technical Supplies Branch, Washington, D.C., Ref: P-43.

(i) *Records.* All laboratories assigned a preference rating by or pursuant to this order, shall keep and preserve for two years, copies of all purchase orders or contracts applying such rating.

(j) *Violations.* Any person who wilfully violates any provision of this order or who, in connection with this order, wilfully conceals a material fact or furnishes false information to any department or agency of the United States, is guilty of a crime, and upon conviction may be punished by fine or imprisonment. In addition, any such person may be prohibited from making or obtaining further deliveries of, or from process or use of, material under priority control, and may be deprived of priorities assistance.

(k) *Applicability of Priorities Regulations.* This order and all transactions affected thereby are subject to all applicable provisions of the priorities regulations of the War Production Board, as amended from time to time.

(P.D. Reg. 1, as amended, 6 F.R. 6680; W.P.B. Reg. 1, 7 F.R. 561; E.O. 9024, 7 F.R. 329; E.O. 9040, 7 F.R. 527; E.O. 9125, 7 F.R. 2719; sec. 2 (a), Pub. Law 671, 76th Cong., as amended by Pub. Laws 89 and 507, 77th Cong.)

Issued this 5th day of November 1942.

(signed)
ERNEST KANZLER
Director General for Operations

Part 3119—Reagent Chemicals

PREFERENCE RATING ORDER P-135

3119.1 Preference Rating Order P-135

(a) *Definition.* For the purposes of this order the term "reagent chemical" means any chemical prepared and packed for reagent use in laboratories.

(b) *Assignment of Preference Rating.* Preference rating AA2X is hereby assigned to deliveries of any reagent chemical for use by any laboratory for analytical, testing, control, educational or research purposes and to deliveries of any material (not including repair, maintenance and operating supplies) which will enter, at any stage, into the production of any such reagent chemical.

Nothing contained in this order shall prevent the use of any other or higher rating to which any person operating a laboratory or any producer of reagent chemicals may be entitled by reason of any other preference rating certificate or order.

(c) *Application and Extension of Rating.* The preference rating assigned by paragraph (b) hereof shall, subject to the provisions of paragraph (d) hereof, be applied or extended only in accordance with the provisions of Priorities Regulation No. 3, as amended from time to time.

(d) *Restrictions on Applications and Extensions of Rating.* The preference rating hereby assigned shall not be applied:

(1) To obtain deliveries of any reagent chemical or material:

(i) Which will be incorporated in, or which will enter into any chemical reaction directly involved in the manufacture of, any product, other than a reagent chemical, manufactured for sale;

(ii) Which will be used in the rendering of any service other than analytical, testing, control, educational or research laboratory services.

(2) To obtain deliveries during any calendar quarter of reagent chemicals, or material (not including maintenance, repair and operating supplies) which will enter, at any stage, into the production of reagent chemicals, greater in dollar value than twenty-five per cent (25%) of the total dollar value of reagent chemicals and such materials, delivered, for analytical, testing, control, educational or research purposes, or for the manufacture of such reagent chemicals, to the person applying or extending the rating hereby assigned, during the twelve (12) month period ended September 30, 1942: *Provided, however,* That if, during any calendar quarter, the dollar volume of production, services rendered, appropriations for research or number of students enrolled, by the person applying the rating hereby assigned, is greater than for the corresponding quarter of the twelve (12) month period ended September 30, 1942, the allowable dollar value to which the rating hereby assigned may be applied in terms of this paragraph (d)(2), may be increased in proportion to the increase in production, services rendered, research appropriation or enrollment.

(e) *Miscellaneous Provisions.* (1) Applicability of Priorities Regulations: This order and all transactions affected hereby are subject to all applicable provisions of priorities regulations of the War Production Board, as amended from time to time.

(2) Communications to War Production Board. All communications concerning this order shall, unless otherwise directed, be addressed to: War Production Board, Chemicals Branch, Washington, D.C., Ref: P-135.

(P.D. Reg. 1, as amended, 6 F.R. 6680; W.P.B. Reg. 1, 7 F.R. 561; E.O. 9024, 7 F.R. 329; E.O. 9040, 7 F.R. 527; E.O. 9125, 7 F.R. 2719; sec. 2 (a), Pub. Law 671, 76th Cong., as amended by Pub. Laws 89 and 507, 77th Cong.)

Issued this 5th day of November 1942.

(signed)
ERNEST KANZLER
Director General for Operations

Wartime Distribution of Sanitary Engineers

War Manpower Commission Release

CHAIRMAN Paul V. McNutt of the War Manpower Commission, on January 18, took steps to provide for the more effective distribution of sanitary engineers among the Army, Navy, Public Health Service and state and municipal agencies. It was explained that the war demands for these technically trained men have been so great that a national shortage is now threatened. To locate and assign such personnel to the various war services, Mr. McNutt established a committee within the Procurement and Assignment Service for physicians, dentists and veterinarians.

Abel Wolman, Professor of Sanitary Engineering at The Johns Hopkins University since the summer of 1942, was named chairman of the committee. Mr. Wolman has been chairman of the National Research Council's Committee on Sanitary Engineering. This committee was established at the request of the Surgeons General of the Army, Navy and Public Health Service for advice and assistance in dealing with specified activities in the field of sanitary engineering.

Because the National Research Council Committee had already considered the difficulties found in the procurement and assignment of sanitary engineers for military and civilian groups in the United States and foreign countries and had begun a canvass to determine the availability of the engineers and the prospective demands for them, Mr. McNutt asked its members to serve on the new committee. In addition to Mr. Wolman, who will sit as a member of the directing board of the Procurement and Assignment Service, the other members of the committee are:

Kenneth F. Maxcy, Secretary, Professor of Epidemiology, The School of Hygiene and Public Health, The Johns Hopkins University, Baltimore, Md.

Harold E. Babbitt, Professor of Sanitary Engineering, University of Illinois, Urbana, Ill.

Based on WMC Release PM-4285, dated January 18, 1943.

F. C. Bishop, Assistant Chief, Bureau of Entomology and Plant Quarantine, U.S. Department of Agriculture, Washington, D.C.

V. M. Ehlers, Chief Engineer, Texas State Board of Health, Austin, Tex.

Gordon M. Fair, Professor of Sanitary Engineering, Harvard University, Cambridge, Mass.

H. A. Whittaker, Chief Engineer, Division of Sanitation, State Department of Health, Minneapolis, Minn.

J. K. Hoskins, Senior Sanitary Engineer, U.S. Public Health Service, Washington, D.C.

No one knows how many sanitary engineers in the United States are not already in some of the services directly or indirectly related to the war, but the preliminary survey made by the committee indicates that the known number is not many more than 1,000. It is obvious, therefore, that the country will have to be combed for the enlisted engineers, and that training courses will have to be established for those not fully qualified for service, exercising the greatest care in their allocation.

In the above-mentioned canvass, which the committee will continue, consideration will be given to the requirements of the Army, Navy, Air Corps, the U.S. Public Health Service, the Office of Civilian Defense, the Office of the Co-ordinator of Inter-American Affairs, the Provost Marshal General's office and agencies in civilian operations. It is estimated that by the end of 1943, the Sanitary Corps of the Army will be more than double its present size and that many engineers, but a smaller proportion, will be required by the Navy.

The U.S. Public Health Service has lost a number of its sanitary engineers to the armed forces, but this service, in turn, has greatly depleted state, municipal and health departments. It will be necessary to find approximately 200 more engineers for the Public Health Service in 1943.

The rolls of the State Health Departments have been depleted some 40 per cent on the average for the entire country. It is expected that this will be increased to approximately 60 per cent. Some of the individual state departments of health, on the other hand, have had their forces of sanitary engineers cut by approximately 90 per cent.

The demands for sanitary engineers in foreign service, both military and non-military, are expected to increase rapidly in 1943.